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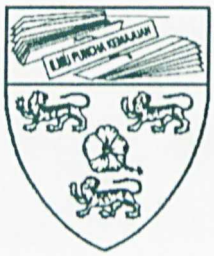

Field Service System

By
Khoo Chai Ee

Under supervision of Ms. Su Moon Ting
Moderator : Mr. Mohd Khalit othman

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ABSTRACT

Field Service System is a web-based system that streamlines and automates the field service function in order to create new revenue opportunities, retaining the customer and making the field service organization staying ahead of the competition.

Microsoft Active Server Page.NET (ASP.NET) is chosen as the application language to develop the system. Microsoft SQL Server 2000 is selected as the data store with ADO.NET as data access technology. Internet Information Server 5.0 acts as the web server while Internet Explorer 6.0 is the web browser that can support the system. The 3-tier architecture is used in developing the system

The Field Service System consists of 6 major modules: Login module, Service Call Management for the customer, User Management for system administrator, Sales Management for sales department, Dispatch Management for the technical manager and Work Order Management for the technician.

For the customers, they can request service and check the order status. The system administrator can manage and monitor all the system's users. For the sales & marketing department, they can track and control parts / components and customer's data more systematically. The technical manager can increase technician's productivity by assigning appropriately skilled technician, read closed work order report and generate reports. Besides that, the technicians can remain in contact with their home base. They can access the customer's service agreement information, installed equipment, work order history, parts availability and etc online.

ACKNOWLEDGEMENT

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Special thanks to Mr Basri mohd Ghazi, the technical manager of Business Information Technology Sdn.Bhd (BIT), for his patience in explaining to us the business operation in BIT and sharing his valued experience and knowledge with us regarding Field Service System so that the system is more realism.

Last but not least, I would also like to thank my friends and course mates for sharing ideas and their constant moral support as well as suggestions for the solutions to our project related problem.

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CHAPTER 1

INTRODUCTION

1.1 Project Overview

When a product breaks and needs repair, when the time comes to perform scheduled or preventative maintenance, a field service technician must be sent out to perform the work. Field service — defined as the processes involved in servicing products in the field after they have been sold— is a specialized subset of functions under the broad umbrella of CRM

Nowadays, as the products and services companies offer are becoming more and more alike in terms of features and functionality, providing better service provides a way for a company to differentiate itself from the competition and ensure satisfaction. After-sales service repeatedly has been shown to have as significant an impact on consumer loyalty as the performance of the products themselves.

This project is about developing a web-based system that streamlines and automates the field service function in order to create new revenue opportunities, retaining the customer and making the field service organization staying ahead of the competition. This system is named as Field Service System or FSS in short.

The development of FSS is focused on helping the field service organizations to effectively manage their customer service by facilitating the job scheduling among the field service workers, management of customer information and report generating.

Field Service System enables a company to schedule and communicate with field service personnel. It also allows the organization to monitor report and measure

field service activities. A key challenge in today's business economy is the administration and coordination of field service management. The provision of full service to customers, adding value to both product sales and support, is an opportunity not to be missed in today's tougher economy, thus becoming more service focused, rather than product centric.

One of the best ways to improve service to your customers is by knowing them better. The ability to accurately profile your customers will keep you one step ahead and help you better manage customer relationships. The degree to which your field service has relevant information will strongly affect your customer experience. Information about the customer made available to the person coming in contact (here, the focus is field service staff) with the customer can go a long way not only in clinching the deal but also creating a very good relationship with the customer for future business.

When all information is at hand and computing can be performed, field service staff or technician have a much better chance of accomplishing the entire job done at the customer's site on the first call. They can check inventory, for example, order and reserve parts. Technicians can concentrate on executing their jobs rather than gathering customers' details. Customers are happier, and companies can cut costs by minimizing return visits, follow up phone calls, redundant data entry and other clerical work.

For the case study purpose, throughout the study of the system development, the Field Service System is developed based on the business operation of Business Information technology (BIT), a Malaysian-owned private limited company

incorporated in Malaysia on 2nd October 1995 that offer full-service advanced Information Technology solutions.

1.2 Current Problem Definition

1.2.1 Company Background

As this Field Service System is developed based on the business operation of BIT, let's take a look at the background of BIT. BIT is a Malaysian-owned private limited company incorporated in Malaysia on 2nd October 1995. It was established with the primary objective to offer full-service advanced information technology solutions. BIT business approach is to concentrate on delivering advanced and total information technology solution with 100% customer satisfaction. BIT strives to accomplish their mission through a vigorous quality program that is backed by unparalleled customer support. BIT considers their first and most crucial goal is to fully meet the needs of every client. From the organizational chart as shown in **Appendix A**, it is obvious that BIT aspiration is to deliver "total solutions" in every client settings without compromising customer supports.

BIT takes pride in the relationship they've built with leading hardware and software providers. BIT top honors include *Microsoft Certified Solution Provider, Cisco Certified Premiere Partner, Mod-Tap Certified Installer, HP Registered Reseller and Intel Network and Communication Partner*. This relationship has enabled BIT to offer 2 unique solutions, which are Microsoft Business Solution and Cisco Network Solution. BIT's team of sales representatives, engineers and service technicians are certified to support an extensive line of hardware and software. Besides that, BIT also focused on three areas of services, which are Internet Related Services, Network Integrated Services and Multimedia Deliver Services.

1.2.2 Overview of the Current Field Service System

At present day, BIT uses a relatively simple computerized system to facilitate some of the tasks related to field service operation. The system is mainly use to keep track on the customer service request information.

The following section depicts all the general processes and tasks involved in BIT's field service operation and the role of this current system in facilitating these tasks.

Customer call management

As BIT does not have a single point of contact/ help desk, any of the BIT's engineers or technician will manages and handles service call from customers during office hour. Details or information of the service call will be recorded into the current system during the call. This will allow the technical manager, technician or engineer to track customer service request. Besides that, customer will have to call back to check for service status or the technician will have to update the customer regarding this matter from time to time through phone. It is really ineffective from the cost point of view.

Work Order

Normally the engineer or technician that received the call will try to solve the customer's problem over the phone. If the problem cannot be solved, a work order is created and an appointment is scheduled When the technical manager get the pending work order(s), he will assigns the order(s) to technician who is around the

office, by taking into account the customer's entitlement, priority of the problem, technicians' expertise and their workload. Technician manager will then inform the selected technician regarding the new task manually. There is no proper work scheduling management that assists the technical manager in managing the work orders. It is hard for the technical manager to track the location and the availability of the suitable technician. As a result, he always has difficulties in selecting the most suitable technicians for a particular task.

Customer Contract

Currently, customers' service contracts management which includes the customers' contact information is kept as paper documents. There is no computerized system to manage all the details about these contracts. As a result, technical manager or technician will have to search through a huge pile of papers documents in order to get the customer's information when customers' call for service request. This is particularly inconvenient to mobile technician who is working at customer's site. Besides that, the technical manager might miss out the preventative management schedule for a certain contract as all the information about customers' service agreements are all paper-based documents.

Parts and Inventory Management

In order to fulfill customer request, BIT has kept parts or components for some of the products. All the parts details are recorded by using Microsoft Excel

currently. Records of the parts are not categorized and only a few details can be kept for each of the record. This program are not integrated with the current system

Order / Repair Fulfillment

When the technician gets a new assignment or schedule, he will gather the customer information and problems details from the web based system before he drives to the customer site. He will also have to refer to the inventory list that kept in Microsoft Excel to get the parts availability because inventory management is not part of the current Field Service System. As a result, the field service technician will have to call the sales department to check for the availability of a certain parts or components when they are at customer's site. It is inconvenient to the mobile technicians.

Close Work Order

After performing work on site, the technician will either close the work order, signifying that all work is complete or schedule another appointment to finish any remaining work. In closing the work, the technician will report to the technical manager by submitting paper report weekly. The report includes resolution that has been taken, parts that is used for the replacement, time taken to solve the problem and claim for allowances. The information captures may not be accurate as technician only reports the closed work order after they are back at the office and delay of filling in reports.

1.3 Project Motivation

The driving force behind the decision to come out with the Field Service System is the limitations and weaknesses of the current system that are used by BIT in the field service operation. Many of the tasks are not automated and are still done manually. As a result, this may delay service delivery time, decrease customer satisfaction and reduce organization profitability n a long run.

Listed below are the major weaknesses of the current system that pursue the need of developing the Field Service System:

a) There is **no central database** that stores all of the vital information that is related to the field service operation.

- Vast collection of valuable data including order entry, customers' information, service contract, inventory and parts management, scheduling are scattered across the company and could not be shared and reuse from different locations. All these data can be combined and transform into concise information that can be used to generate breakthrough improvements.
- For example, every piece of the data and information about the customer are keep as paper document in the physical folder. The employee will have to search through a huge pile of paper documents, in order to get the customer information when customers call for a service request. It takes some times for the help desk unit to access to customer's service contract details as the contract is keep manually as papers and files. The process of

managing the contract management manually will become harder as number of customers increase from time to time.

- Besides that, parts lists are keep in a separate program from the customer information. This makes information checking and retrieving difficult to carry out.

b) The **current** system is not **accessible through the Internet**

- Customer service requisition can only be done during office hours. Customer will have to call BIT to check for service status or the technician will have to update the customer regarding their service status through phone from time to time.
- Besides that, the mobile field technician will have to go back to the office/ call the office in order to get the relevant information or details of each work orders that is assigned to them. Much time is spent on searching document rather than manipulating the information stored within the document. It is impossible for the technician to provide the level of service that the customer expects if information about the customer is scattered throughout the organization or is just plain unavailable.

c) There is **no proper work scheduling management** that assists the technical manager in managing the scheduling of work order.

- There is no information that can be referred by the technical manager regarding the movement and availability of the technicians. As a result, the technical manager always has difficulties in dispatching/ send the most suitable technician for a particular service order.
- The technical manager might miss the preventative maintenance date, as all the service contracts are paper-based.

d) It is difficult for the technical manager to monitor the performance or track the location of the technicians as there is **no related report generated** from the current system.

The existing Field Service Management System needs to be enhanced to overcome the problems. The numerous weaknesses of the current system used by BIT company means that the enhancement to this system is imminent.

1.4 Project Objective

The main goal of the proposed Field Service System is to eliminate, if not all, most of the problems of the current Field Service System. The development and implementation of this project is to achieve the below objectives:

a) To develop a **web based** Field Service System.

- An Internet connection is all the users need to access to the Field Service System from virtually anywhere – a home computer, customer location and etc.
- It enables customer to communicate with their service providers 24 hours a day, 7 days a week (24 × 7).
- With Internet access, a field technician can be in touch with the dispatcher/technical manager as much as needed. Technicians are able to access to jobs schedule, client information and the entry of labor and parts for jobs on-line through a web browser. Through a standard web browser, technician can be connected to the enterprise resources – whenever and wherever they are.

b) To create a centralized **data management system** from a variety of source.

- To developed a Field Service System that is able to store and centralized the valuable data of customer's profile, and product's information, contracts and warranties, service history, parts and inventory information.

Thus, any information needed can be accessed with ease and the integrity of information always being preserved.

- Time needed to retrieve information will be reduced sharply. Besides that, every contact point in the company will share the same information about customers, parts and inventory, and strategies/tactics for problem resolutions.
- It is important for the technician to have the entire customer's information readily available in one central location and access customer data from a remote location, in order to assess and solve customer's issue(s).

c) To **reduce manual paperwork**

- Management of customer's contract will be improved. Technicians will be able to report closed work orders in electronic format without having to travel to the office to pick up and drop off paperwork, providing accurate and timely information.

d) To **optimize scheduling** and **dispatch management**

- Overall technician utilization can be improved through better scheduling management. Efficient management of the field workforce requires that decisions based on multiple variables: technician skills and availability, parts, priority, customer preference, location and more. And these must be considered for every customer call.

- Thus, with the FSS technical manager will be able to schedule work orders based on technician availability and skill sets after reviewing the dispatch board which displays the technician's current schedule and availability.
- Besides that, technical manager also have instant access to customer contract's details, the technical manager will know instantly if equipment is covered by a service contract and see what priority the service call is given based on the contract or how important the customer is. In short, the right technician gets assigned to the right job with the right parts, preventing wasted time and travel.

e) To **improve technician's productivity**

- Technicians are able to access to their own work orders on line, allowing them to see assigned jobs, thus eliminating trips to the office to pick up work order.
- An internet connection is all the technician need to access to essential customer information, service history, parts availability and product repair information they need while in the field, thus enables technician to perform their field work more effectively by completing their work in a single visit and results in customer satisfaction.
- With instant access to all the necessary info through the Internet, technician is less reliant on the company staff, field engineer can concentrate on executing jobs rather than gathering customer's details.

f) To **increase customer satisfaction**

- Customers can open a new service order, review the progress of service call already placed, access to their contract information by just simply logging on to the Internet.
- Technicians will be able to improve responsiveness with up-to-date information, which is exactly what customers want. Ensuring predictability and increase single-visit completion rates.

1.5 Project Scope

The Field Service System will be targeted to any field service organization and specifically to BIT. This system will be useful especially for company that needs some kind of transition from a manual system to a computerized system that manage to automate, if not all, most of the operations involved in field service function .

1.5.1 Functional Scope

This project involves six main modules, namely login module, service call management module, user management module, sales management module, dispatch management module, and work order management module. Below is the role of each target user's and its functional scope:

1.5.1.1 User

User of this proposed Field Service System consists of customers, system administrators, Sales and Marketing, technical manager and technicians. The Field Service System will provide user with the access to the system through the **Login module**.

a) **System access** where users can login to the system using a valid userID and password.

b) **Change password** where users are allowed to change password according to their needs.

c) Users can logout securely through this module.

1.5.1.2 Customer

BIT support two types of customer or services to their customers, that is maintenance contract and warranty service. Under maintenance contract, BIT will have corrective maintenance and preventive maintenance with the customer service. For preventive maintenance, service will be provided every six months to all equipments listed in the contract while service will be provided upon customer request for corrective maintenance. On the other hand, service only provided on the parts or equipments that have warranty for the warranty service's customer.

The Field Service System will provide some functionalities which are accessible by a customer through the **Service Call Management module**.

a) **Service request** where customers can place a service order on line at anytime.

b) **Order status** where customers are able to check on line the status of their service order. They will be able to view the reported problem which they made previously.

c) **Contract and product details** that provide the customer access to their personal details, service agreement and list of products which they bought from the company.

1.5.1.3 System Administrator

The responsibility of system administrator is to manage all the FSS's user profile. This includes all the employees and customers who have the authorization of accessing the system.

The proposed system will provide some functionalities which are accessible by system administrator through the **User Management module**.

a) **Employee profile** that helps the system administrator to manage the employee profile.

b) **Customer profile** that enables a system administrator to view the customer details.

1.5.1.4 Sales and Marketing

The responsibility of a Sales and Marketing personnel is to manage all the stuff regarding clients of the company. They have to monitor the correlation among the customer's data, such as customer profile, product information and service agreement.

The proposed system will provide some functionalities which are accessible by a Sales and Marketing personnel through the **Sales Management module**.

c) **Customer profile** that helps the personnel from Sales and Marketing to manage the customer profile.

d) **Customer's product** where the personnel from Sales and Marketing has access to all the information of company's products.

e) **Contract management** that helps the personnel from Sales and Marketing to manage the details of service agreement between a customer and company.

f) **Parts management** that allows the personnel from Sales and Marketing to enter parts information such as parts availability.

1.5.1.5 Technical Manager

The responsibility of the technical manager is just like any other manager, for example to plan, to schedule, to supervise and to monitor his/her employees. The specific responsibilities of a technical manager are to schedule and dispatch the right technicians to the right jobs with the right parts and in the right place. Besides that, the technical manager is also responsible to manage service activities at the customer site.

The Field Service System will provide some functionalities which are accessible by the technical manager through the **DISPATCH MANAGEMENT MODULE**:

a) **Work order listing** where technical manager can view at job listing to monitor open and completed work orders.

b) **Schedule** that offers a visual and graphical representation of technician's workload and schedules that puts the technical manager in complete command of the scheduling and dispatch process.

c) **Preventive maintenance management** that helps the manger to manage the details of service agreement, and to schedule preventive maintenance call, ensuring that contract obligation is delivered.

d) **Customer qualification** where technical manager has instant access to all of the critical customer's information and check details of customer's warranty and service agreement coverage.

e) **Report generator** that generate 3 types of report.

1.5.1.6 Technician

Technician is the field service representatives that are dispatch to respond to customer calls or routine maintenance. At the customer's site, technician will perform the necessary work such as installing equipment or diagnosing and repairing problems.

The Field Service System will provide some functionalities which are accessible by the technician through the **WORK ORDER MANAGEMENT MODULE**:

a) **Work order schedule** that provides the technician access to their own work orders on line, allowing them to see assigned jobs.

b) **Work order details** that provides detailed customer and work order information to enable field technicians to effectively prepare for service calls

c) **Parts availability** that provides the technician with parts status and parts availability information.

d) **Service report** that allows a field technician to enter service information over the web such as status changes, work performed, parts used, and service notes. This updates the central server immediately, providing management a comprehensive view of service operations

e) **Solution reference** where all work done is searchable along with knowledge learned on the job.

1.5.2 Non-functional Scope

The system will need to have a certain level of security features, such as user access control for different level of users. Last but not least, the system shall provide a set of easy-to-use graphical user interfaces for users to navigate along the system.

1.6 Project Limitation

The limitations of this project are shown as below:

a) This project will not support bar coding for the stock code / product code, as we do not have bar code reader support.

b) User will not have the availability to customize the layout of the web page.

c) This project only supports single communication language, which is English

d) This Field Service System does not support billing of parts and equipment replacement for customers. All the service costs are included in the service contract.

1.7 Expected Project Outcome

a) When implemented, the Field Service System should be able to achieve all the project objectives within the scope listed in section 1.4. Listed below are some of the major expected outcome:

- A field service system which is able to automate most of the tasks / activities involved in the field service operation.

- An Internet-based field service system which is accessible by the valid user at anytime and anywhere.
- A field service system which is able to reduce cost of operation and improve the effectiveness of customer service.

b) Upon completion of the courseWXES3181, project's objectives, limitations, and scope should be defined properly. A considerable amount of research and review should be done on the similar systems that provide the same functions as this project.

c) Methods, techniques and tools that will be used in this project should be determined after considering the available technologies in the market. This phase of development will also cover system analysis, by understanding the functional and non-functional requirements of the system. System design should be discussed and drawn out. These include the system architectures, development module, context diagram, data flow diagrams, database design and Graphical User Interface design

1.8 Project Planning

This project is a 2 semesters project, it will be separated into 2 phase. The first phase of the project, which is under the subject code WXES3181, focus on the analysis and conceptual design of the project. On the following semester, the second phase of the project will focus on the development of the Field Service System.

1.9 Project Schedule

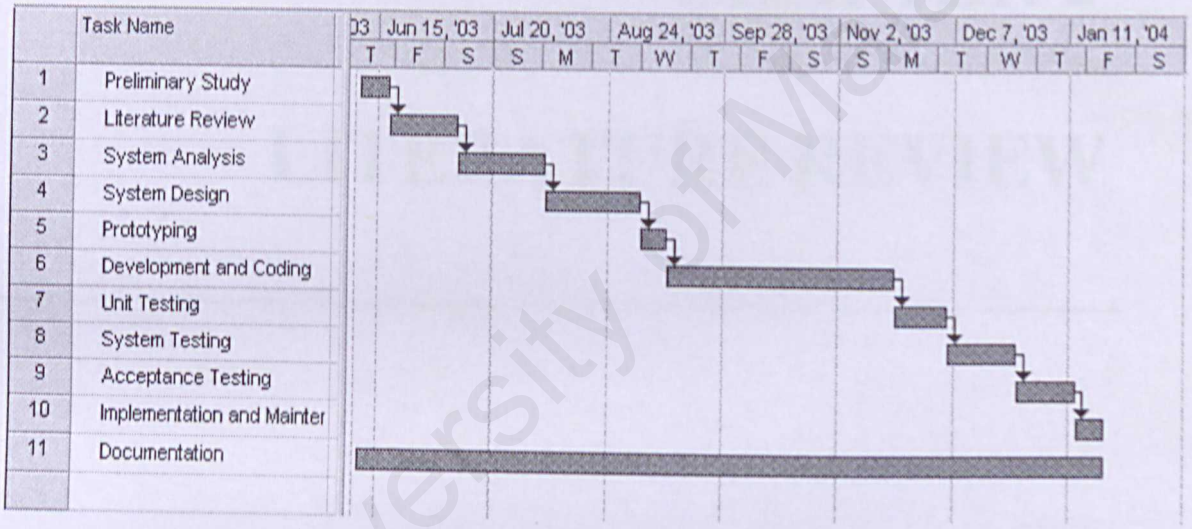


Figure 1.1: Project Schedule

CHAPTER 2

LITERATURE REVIEW

2.1 Definition of Literature Review

'Literature' as define in the Encarta dictionary means writing on specific subject: the body of published work concerned with a particular subject. Where as, in the same dictionary, *'Review'* is considered as a reexamination of something: another look at or consideration of something or in transitive form – to look at something critically, an act to examine something to make sure that it is adequate, accurate or correct.

Literature Review summarizes, interprets and evaluates existing "literature" (or published material) in order to critically establish current knowledge of a subject. The purpose for doing so relates to ongoing research to develop that knowledge: the literature review may resolve a controversy, establish the need for the traditional research and/or define a topic of inquiry.

2.2 Purpose of Literature Review

The purpose of doing literature review mainly is to understand the performance of the current system and to analyze on available tools in developing this Field Service System. In the process of reviewing and reexamining, it helps student to further understand the subjects and able to study, reorganize and synthesis conclusion respectively on each topics.

2.3 Information Finding Techniques

In order to firm up the system's requirement specification, works and efforts on finding and gathering information had been done. Few techniques had been used as describe below together with the summarized outcome for each technique.

2.3.1 Internet surfing

There is a vast range of valuable and up to date information available on the Internet. By accessing Internet, information can be obtained through journals, articles, e-news and others. Browsing and searching through Internet search engines can obtain a listing of related sites on the system.

For this method to be effective, we chose to use several renowned search engines to look for research materials around the Internet, namely Google.com, Yahoo! and several other search engines. Selection had been done and we filtered through the results to find the most reliable and suitable material to fit into our project. In other words, only verified information from trusted source are to be consider in the literature review.

2.3.2 Interview

In order to capture and eliciting more precise user requirements on the new system, interview's questions had been prepared and an informal interview with BIT's technical manager has been conducted. It is an inexpensive way to gather data as well as a feasible way to reach to potential users to allow more analytical survey

on users' specifications. During the discussion, changing of opinion had indeed improved the understanding on developing a system that is more realism and compatible to real world working system.

Through the interview, the performance of the existing Field Service System and overall satisfaction with the system had been correlated. In general, the rating of the current system shows that it is not sufficient enough with the growth of customer demand. A more systematic approach is suggested and to be taken in order to generate higher satisfaction among staffs. The Interview's questions and the information gathered are enclosed in **Appendix B** for further reading.

2.3.3 Reading Materials

Apart from the Internet, research also had been done on sample thesis and reference books that have similarities with the proposed system. Most of the information especially guideline in writing the reports was obtained from the past year thesis which can be found from the Library of Faculty of Computer Science and Information Technology. Proper documentation techniques were also learnt during the research. In addition, printed journals and reference books regarding to the system development has been the main source of obtaining information related to the subject being studied. It is has more credibility than those information obtained from the Internet.

2.3.4 Discussion

Discussion sessions have been conducted with team member, supervisor as well as the BIT's technical manager. These discussion and brainstorming session has helped in identifying all possible features for the Field Service System. Discussion with BIT's technical manager helped us to further understand the requirements of the system.

2.4 Analysis on Field Service

2.4.1 Customer Relationship Management (CRM)

Customer Relationship Management (CRM) strategies have been around since the first bazaar. It is defined as the establishment, development, maintenance and optimization of long-term mutually valuable relationships between consumers and organizations. Successful CRM focuses on understanding the needs and desires of the consumer and is achieved by placing these needs at the heart of the business by integrating them with the organization's strategy, people, technology and business processes.

Primarily, customer relationship management is a business strategy, but it is a business strategy enabled by advances in technology. Widespread implementation of customer information, Enterprise Resource Planning (ERP) systems, sales force automation, and integrated point-of-sale systems have made customer information readily available in large volumes. Reduced costs and higher levels of performance for database management platforms enable enterprises to gain access to this customer information and gain new insights into their customers and their behavior through a variety of analysis methods. Advances in contact management technology and supporting infrastructure allow enterprise to take advantage of this information in increasingly cost-effective and innovative ways. Perhaps most significant, the Internet provides a completely new way for an enterprise to interact with its customer-the electronic channel, or the e-channel.

The three main elements of CRM are sales force automation, customer service / call center management and marketing automation as shown in Figure 2.1.

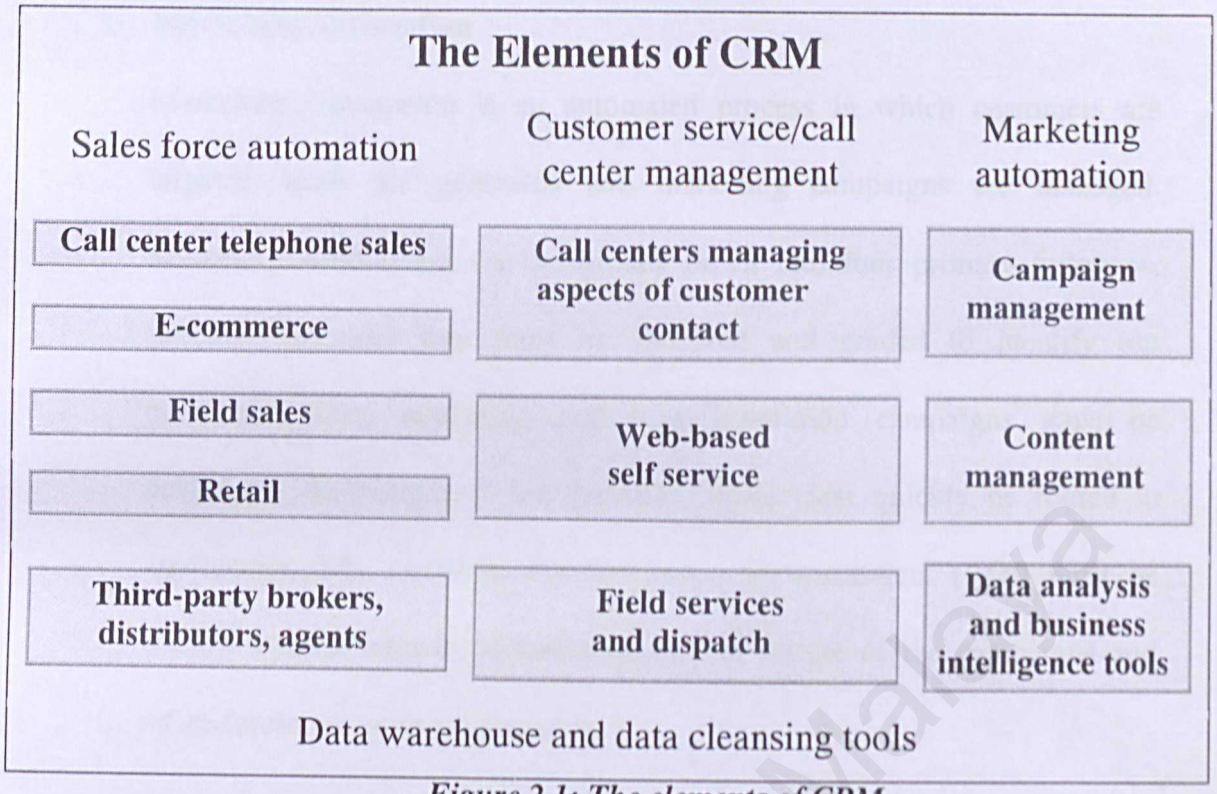


Figure 2.1: The elements of CRM

- **Sales Force Automation**

  Sales Force Automation is an automated sales management process that includes lead generation, forecasting and closing business.

- **Customer Service**

  Customer Service addresses post-sales issues in a responsive manner. Customer service and support includes the following:

  - Field service and dispatch technicians
  - Internet-based service or self-service via a web site
  - Call centers that handle all channels of customer contact, not just voice

- **Marketing Automation**

  Marketing Automation is an automated process in which customers are targeted, leads are generated and marketing campaigns are managed. Marketing Automation can be broken down into four primary functions. Initially, customer data must be analyzed and graded to identify top prospects. Next, marketing and lead generation campaigns must be developed. As campaigns are executed, leads must quickly be routed to appropriate sales channels. Finally, return on investment (ROI) must be tracked against sales to ascertain success or failure of the campaigns and refine future marketing approaches.

In this assertion, we will look particularly in customer service and support of CRM with the focus on field service.

2.4.1.1 CRM – From A Service Perspective

To optimize customer relationships, intelligent, automated field service applications that leverage the full information resources of the enterprise are essential. Field service is no more a distinct functional area of the company than sales, marketing, customer service, or product development. All are mutually dependent, and all are focus on one thing; giving the customer what they want.

Service quality can be boosted to unprecedented levels even while the costs of delivering that service are minimized and the opportunities for cross-selling and

up-selling are optimized. The post-sales relationship is an absolutely essential element to customer retention.

Today's service organizations face multiple and contradictory pressures. They must be able to handle ever-increasing workloads while reducing and improving customer satisfaction at the same time. At a time when the products and services companies offer are becoming more and more alike in terms of features and functionality, providing better service provides a way for a company to differentiate itself from the competition and ensure customer satisfaction.

2.4.2 Field Service

'*Field*' as define in the online dictionary means an area or region where business activities are conducted while '*service*' means installation, maintenance, or repairs provided or guaranteed by a dealer or manufacturer. Combination of these two words can be defined as the processes involved in servicing products in the field after they have been sold.

Field service is a specialized subset of functions under the broad umbrella of CRM. It shares several of the key mandates of broader CRM: the need to deliver increasingly better service at the lowest possible cost, the need to leverage service as a differentiator in an intensely competitive marketplace and the need to assemble customer data into a single view in order to fully understand the customer and be prepared to meet the challenge of delivering excellent service.

2.4.3 Field Service Process

The service process can be divided into several components. As shown in **Appendix C**, it is generally starts with the company's objectives and strategies. The service process will then incorporate with internal and external environment of the organization to ensure the appropriateness of the strategy and objective. This figure also provides a checklist of activities that need to be performed as a whole to ensure the smoothness of the service operation. This particular guideline may be use by any organization to aspect that should be focus on in order to obtain additional profit. Normally not all of these aspects will be take into consideration especially for a small and medium size company.

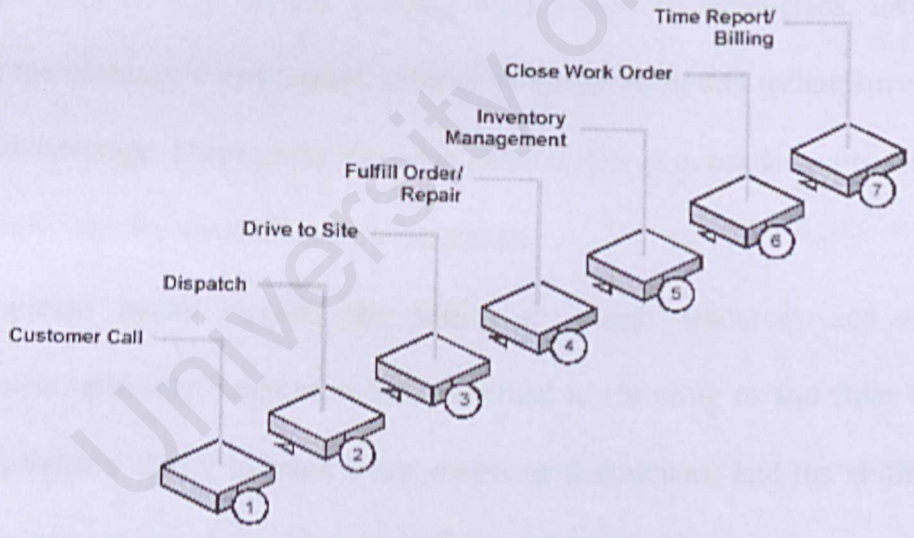


Figure 2.2: Field Service Process

The field service operation generally comprises of several processes as shown in the Figure 2.2. Listed below are all the processes involved in the field service operation and some common issues that immerge for each of the process.

I. Customer Call

A customer call initiates the field service process. Customer information and problem description are logged and customer entitlement is verified. If the problem cannot be resolved over the phone, a work order is created and an appointment is scheduled. The work order opened in this step is tracked and managed until closure.

Common issues include the time to answer a call; the ability to access customer service history; the accuracy of entitlement checks; the ability of the call taker to resolve and investigate problems; and the ability of the call taker to contact technicians directly.

II. Dispatch

The dispatch step assigns pending work orders to technicians, taking into account the customer's entitlement, priority of the problem and technician expertise and route coverage. Dispatchers may also order and/or ship needed parts directly to the customer site for installation by a technician.

Common issues include the ability to assign resources and schedule appointment optimally; technician time involved in traveling to and from dispatch site; dispatcher's ability to track whereabouts of technicians; and the ability to re-adjust assignment in real-time to accommodate schedule changes.

III. Drive to Site

Assignment or schedule in hand, the technician travels to each customer site.

Common issues include technician's ability to locate customer site; communication and coordination between technician, dispatcher and customer; ability to notify of delays, arrival times and etc.

IV. Fulfill Order/Repair

The technician performs the necessary work at the customer site, installing equipment or diagnosing and repairing problems. To perform the work, the technician may need to consult product manual or a service center. If replacement parts are required, they may be waiting at the site, having been dispatched separately, or the technician obtains from his vehicle stock or orders them.

Common issues include the technician's ability to access customer repair history; capturing labor and parts used during the repair/installation; access to product specifications; availability of replacement parts; and the ability to order part and update parts inventory in real-time.

V. Inventory management

This step coordinates the flow of good and bad parts between warehouses, stocking centers, technician vehicles and repair depots. It deals with parts numbering, cycle counting, bar coding, warranty returns and parts kits.

Common issues include the ability to properly track and locate inventory; investment in and control of assets; maintenance of proper stocking levels; ability to interact in real-time with requests from the field; and ability to forecast service parts demand.

VI. Close work order

After performing work on site, the technician will either close the work order, signifying that all work is complete, or schedule another appointment to finish any remaining work. In closing the work order, the technician captures data that feeds into customer history records, billing, performance measurement, product design and sales forecasting.

Common issues include the time to fill out paperwork; time to re-key the data; obtaining customer sign-off and approval of work complete; and integration between systems.

VII. Time Report/Billing

In the final step of the process, the technician's time and materials information is submitted to the accounting department. An invoice is sent to the customer, consistent with the customer's entitlements and pricing schemes.

Common issues include the time lag between the technician's paper submission and re-keying of data; the length of the billing and collections cycle; the ability to access and integrate diverse data (customer entitlements, labor used, parts used, parts returned and etc.) to produce an accurate invoice.

Heading into a new century, the field service business is thriving. Increasingly complex products and equipment, rising performance expectations and a growing realization of the value of customer satisfaction equate to a burgeoning demand for field service technicians. Despite attempts by manufacturers and resellers to make

products amenable to user-based repair, companies and consumers have little desire or time to maintain and repair complex equipment, preferring to outsource these functions instead.

As confront this swelling demand, field service organizations must also deal mounting internal pressures. Like every other business, field service must find ways to decrease operating costs, increase customer satisfaction and enhance revenues. However, many field service organizations are hampered in their ability to meet these goals by a lack of automation, connectivity and integration in their processes and systems. Often viewed in the past as a low-visibility, back-office function, these organizations have not received the level of investment necessary to keep pace with changing and heightened service demands. Outdated processes, strained scheduling capabilities, spotty access to customer data, reliance on paper forms and parts shortages plague many field service organizations and lead to lower technician productivity, customer dissatisfaction and lost opportunities to capture follow-on business and revenues.

Field service organizations can do several things to improve customers' perception of service quality. Chief among these are improving the responsiveness of the field service unit, ensuring that services are delivered with a high degree of predictability and increasing the odds that work will be completed in a single visit. In order to achieve this, field service automation has plays an important role in enabling field service organizations to better manage all the ways they deal with customers.

Nowadays, there are quite a number of products or system designed to automate field service operation. These systems differ in content, features, scopes

and objectives. For the following section, we will review some of the existing field service systems in order to get a clear picture of the common features that shared by these systems.

2.5 Analysis of the Existing Field Service System

Analysis and evaluation has been done on the existing Field Service Management System in the market. Most of the systems are sold as software products developed by software development organization all around the world. Brochures or white paper about the Field Service Management system software can be downloaded from the developer's website. Some of them even offered free trial version or demo in order to promote their product. However, most of the free trial version/demo can only be requested through call request or by providing company's information. By analyzing similar system, it has made a big help in giving ideas on the features and functionalities that should be included in the system. Below are the literature reviews on 3 of the software that we were able to download as 30 days free trial version from the Internet.

2.5.1 Case Study 1: Electronic Service Control (ESC)

Demo downloaded from: http://www.coastalcomputercorporation.com

Last accessed: 04/07/2003

Electronic Service Control is a service management software designed with the latest fourth-generation development tools to maximize speed and stability. It will run on any of the following Windows-based platforms: Windows 98, NT 4.0 SP6a, 2000, Millennium and XP.

Using ESC, you can create job numbers and track work-in-progress, keep track of preventative maintenance and much more.

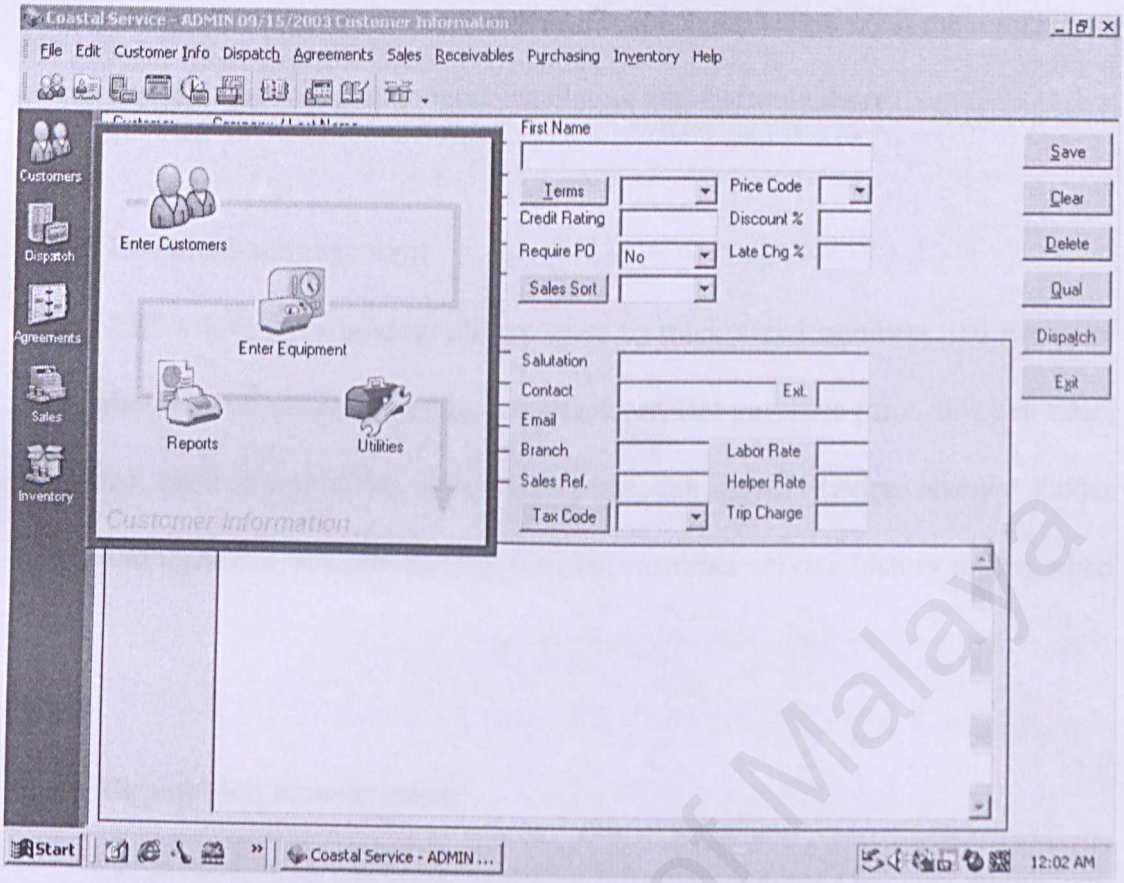


Figure 2.3: Main Page of Electronic Service Control (ESC)

Features of ESC:

- **Customer information management**

Electronic Service Control allows users to track vast amounts of customer information such as, company name, address, phone numbers, multiple locations, credit information, tax codes, labor rates and trip charges.

- **Equipment management**

Track all important equipment information including make, manufacturer, serial numbers, installation and warranty dates. ESC's equipment module allows user to attach equipment to dispatches and service agreements, giving the users the ability

to fully track all service and maintenance calls for that piece of equipment including make, manufacturer, serial numbers, installation and warranty dates.

- **Inventory management**

ESC's Inventory module allows users to track serial numbers and warranty information as well as make, model, manufacturer, last purchase price, buy/sell ratio, and price book information. Inventory items can have Service History Codes attached to them that automatically post to the customer service history record when sold.

- **Dispatching management**

Users can quickly access all pertinent information about customer equipment, service and billing history using the qualification screen. The dispatch entry screen allows users to quickly set up service calls based on priority, skill level, dates and times. The ability to store unlimited notes allows dispatchers to enter specific information for each circumstance. The electronic dispatch board allows you to manage your service calls quickly and easily using a graphical interface with drag and drop features. Easily reschedule calls by simply dragging and dropping them onto the next available technician or day.

Strengths:

- Stylish and user friendly interface, customized toolbars and navigators make day to day work quick and more accurate.

- ESC has the ability to schedule service agreements in a variety of different time periods such as, annual, quarterly, monthly, weekly, and daily.
- Customized toolbars and navigators that allows user to move seamlessly from one area of the software to another, without having to re-key information.
- Provides customizable functions which allow user to add in additional field for information storing.
- Provides a comprehensive user manual / help manual that assist user in using the system.
- Users have the ability to send all service calls to technicians via alpha numeric paging or standard email. This feature includes compatibility with desktop computers, PDA's, handheld computers, web enabled phones, and standard alpha-numeric pagers.

Weakness:

- Customers do not have web access to open new service order or review their service order.

2.5.2 Case Study 2: Eclipse Service Management Software

Demo downloaded from: http://www.eclipseservice.com

Last accessed: 10/07/2003

Eclipse is a fully integrated and powerful service management software system developed by Tech Solutions Inc. Eclipse provides the required functionality of job logging & management, dispatching, historical review, billing, technician notification, labor & parts management, etc. Eclipse runs either as a single user, client/server or client/server & integrated Web Server system. The demo that we have tried out is the single user version.

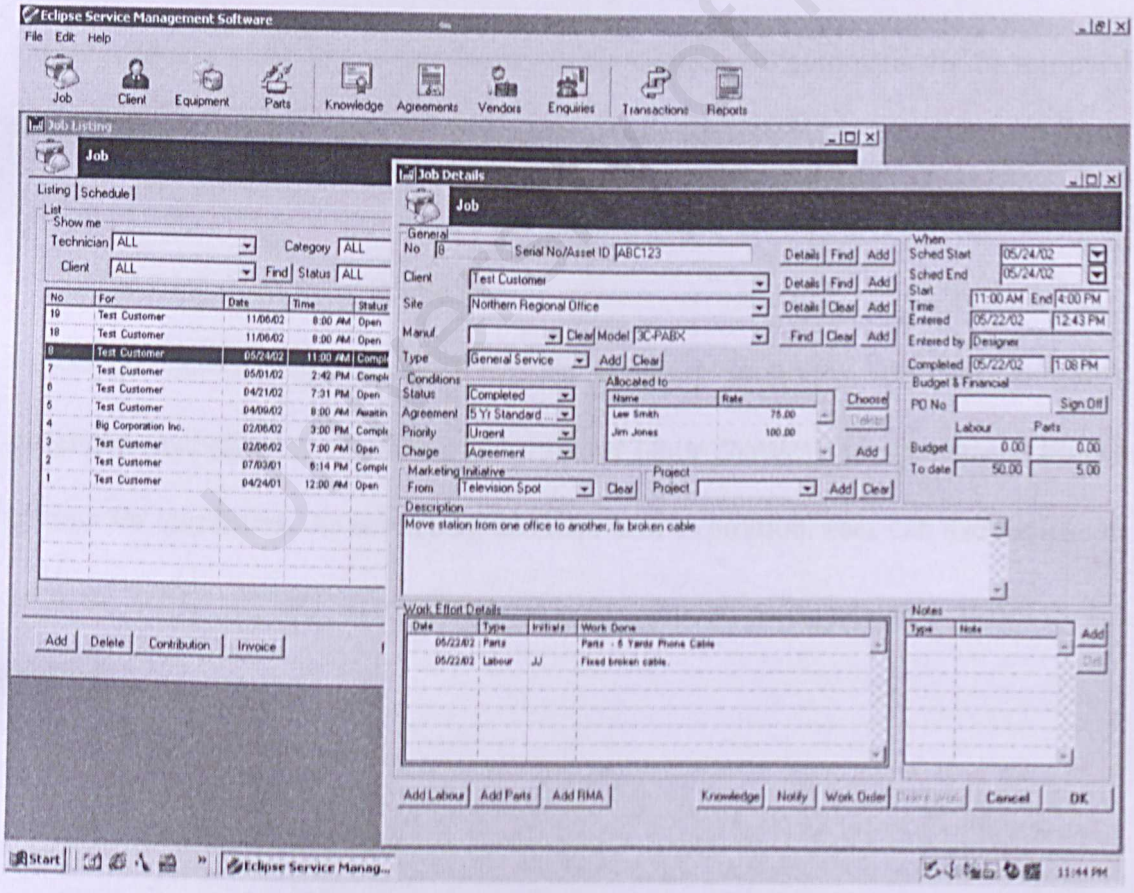


Figure 2.4: Screen Shot of Eclipse Service Management Software

Features of Eclipse Service Management Software:

- **Client management**

Users can store a large amount of information on clients, along with site details, service history and accounting history. Customers can be setup to be automatically notified when a job is entered, via e-mail. You can offer them their own web portal access to the service jobs that you do for them. They can see the status of jobs, and they can even log jobs via the web themselves.

- **Equipment management**

Service history of equipment is kept by serial number or asset ID in the database. Reference the serial number or use the simple chooser to find the item, and then owner, and site where it was last known to be located will automatically be retrieved for the call.

- **Service agreement module**

Support service agreements based on warranty programs, extended warranty programs (including or excluding parts and/or labor charges), pre-purchased blocks of time for customers. As service agreements near expiration, user can use Eclipse to generate letters to sell new agreements, or automatically generate invoices for renewal.

- **Part and inventory management**

Parts have complete movement history, along with simple integration with the accounting system. Technicians have an easy way to add parts to a job. With powerful part finders' built-in throughout Eclipse, they can quickly find the correct part they are looking for. They can also order parts during the service call entry.

- **Job management**

Eclipse presents its list of jobs in an easy to read format. The operator is able to see selective service personnel, or ALL service personnel, selective clients or ALL clients, and selective status (ie. Open jobs, Jobs on Hold, Completed, etc.). Lists can be sorted with a single click of the mouse, in a variety of orders. Jobs can be viewed in complete detail by double clicking on a job in a list.

- **Technician**

Eclipse empowers technician to manage their schedules better, and entering labor done on jobs is a breeze. Job detail screen will also show the work history to date, including both labor and parts used, along with any notes that have been captured by the technicians on the job. Through Eclipse's embracement of mobile computing, and Internet access, a field technician can be in touch with the dispatcher as much as needed

- **E-Mail based job notification**

Eclipse is able to notify both customers and service personnel as jobs are created by electronic mail.

- **Add on Options**

Eclipse Net - add the **Eclipse Net** option to extend access reach for your Eclipse system to Web users, specifically for technicians and customers

Eclipse PDA - Eclipse PDA is an application that runs on either PalmOS or PocketPC enabled devices, to allow a technician to download their workorders and other supporting information to a PDA to take with them in the field

Strengths:

- User do not have to search through multiple pages to find the information, when a job is opened, user gets all the information on one page.
- Eclipse provides a complete custom report generator. Users will be able to use products such as Crystal Report, Powerplay etc to generate their won reports against the Eclipse database.
- Eclipse runs either as a single user, client/server or client/server & integrated Web Server system.
- Eclipse is its own web server, and doesn't rely on third party technologies such as IIS or Apache to host.

Weaknesses:

- There is no customizable function which enables user to add in more details except for the predefined fields.
- In order to install and use the Eclipse service management software, the resolution of the computer has to be changed to 1024 X 768 resolutions.

2.5.3 Case Study 3: AyaNova

Demo downloaded from:

http://www.ayanova.com/service_management_software.htm

Last accessed: 30/06/2003

AyaNova has powerful features to help manage all aspects of service including automated work orders, dispatching, preventative maintenance, searchable knowledgebase, loaners, customer equipment tracking, dozens of management reports and much more. AyaNova is compatible with any network supported by Windows and does not require a network server or other dedicated equipment.

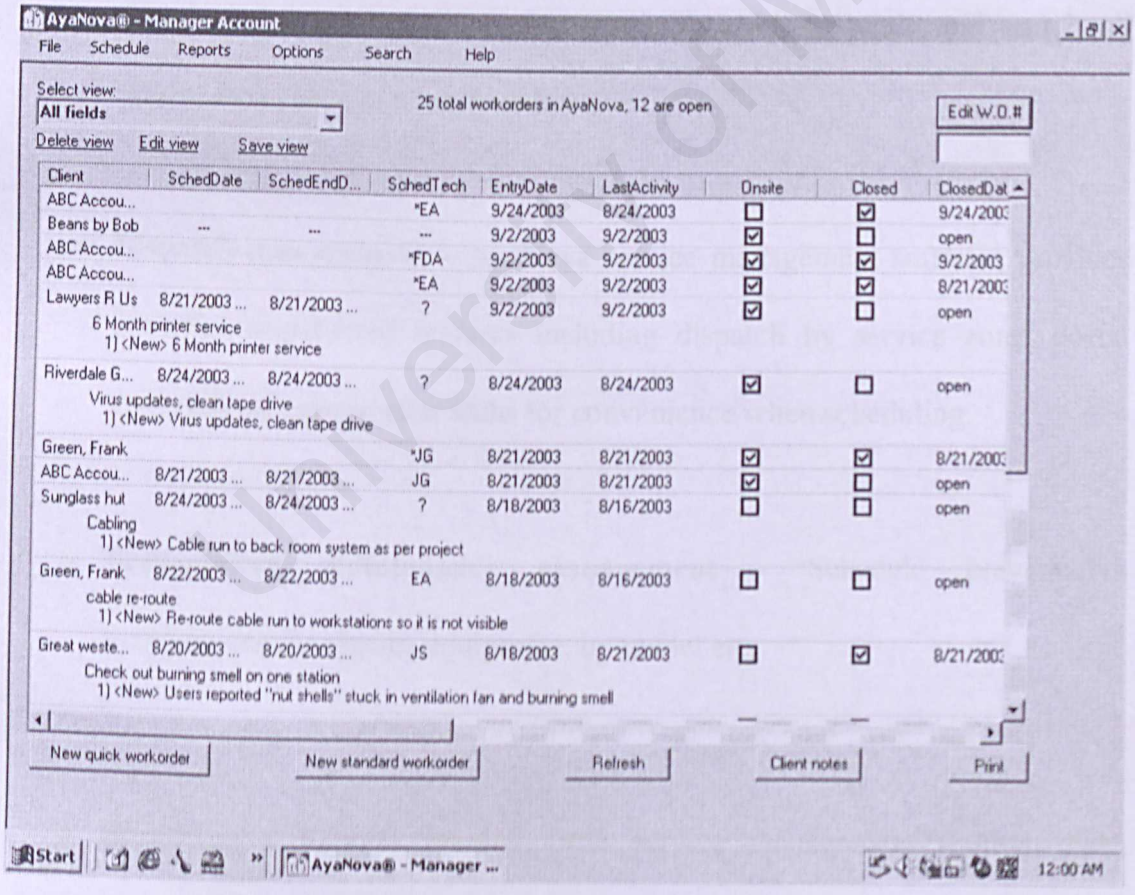


Figure 2.5: AyaNova's Work Orders View

Features of AyaNova:

- **Customer management** - enter all contact information on your clients. Clients are linked to work orders.

- **Equipment database** - Track customer owned and rental / loaner equipment. Enter and track copy/meter counts. Display or print a complete work order service history of each item. Equipment is linked to clients in the system.

- **Parts management** - Enter and track parts for use on service work orders.

- **Work order management** - enter, track, print, schedule and search all service data entered on work orders.

- **Dispatch management** - AyaNova service management software provides powerful dispatching features including dispatch by service zone, postal code, city etc. group your techs for convenience when scheduling.

- **Preventative maintenance management** - Schedule preventative maintenance for clients, equipment, by model etc.

- **Reporting** - Reports ranging from service management (bottom line) information to customer phone books and equipment lists. All reports in AyaNova are fully customizable using Crystal Reports version 8.5 or higher

available from your local software retailer. All reports can be exported to dozens of different formats include Adobe Acrobat, Rich Text format, HTML etc. you can customize the existing reports or create your own management reports using Crystal Reports v8.5 or higher from Seagate Software.

- **Knowledgebase** - Powerful search engine for retrieving any service and other information entered on any work order or other screen in the program. Quick and easy.

- Optional features include a **remote access server** that allows a remote user with nothing more than a standard web browser to access AyaNova remotely via an internet connection to enter work orders, search the knowledgebase, view schedule and more. Customers can request service, check on the status of work orders in progress and even reprint their own work orders all with just a regular web browser.

Strengths:

- A comprehensive system which provides a full capability of service management from the service call to various report generation.

- Each user can set preferences throughout the program and all data entry is tracked by user.

- AyaNova® features a powerful search engine that works just like an internet search engine.

Weaknesses:

- The user interface design is not attractive
- Users may confused by the complicated site flow design. The system is not well organized; too many things are put in one page, this make the page look untidy.

2.6 Analysis on System Architecture

2.6.1 Introduction to System Architecture

Client/server describe the relationship between two computer programs in which one program, the client, makes a service request from another program, the server, which fulfills the request. Although the client/server idea can be used by programs within a single computer, it is a more important in a network. In a network, the client/server model provides a convenient way to interconnect programs that are distributed efficiently across different locations. Computer transactions using the client/server model are very common.

In the usual client/server model, one server, sometimes called a daemon, is activated and awaits client requests. Typically, multiple client programs share the services of a common server program. Both client programs and server programs are often part of a larger program or application.

2.6.2 Two-tier Architecture

Through the appearance of Local-Area-Networks, PCs came out of their isolation, and were soon not only being connected mutually but also to servers. Client/Server-computing was born.

Servers today are mainly file and database servers; application servers are the exception. However, database-servers only offer data on the server, consequently the application intelligence must be implemented on the PC (client). Since there are only architecturally tiered data server and client, this is called two-tiered architecture (as

shown in Figure 2.6). This model is still predominant today, and is the opposite of its popular terminal based predecessor that its entire intelligence on the host system.

One reason why the two-tiered model is so widespread is because of the quality of the tools and middleware that have been most commonly used since the 90's: Remote-SQL, ODBC, relatively inexpensive and well integrated PC-tools (like Visual Basic, Power-Builder, MS Access, 4-GL-Tool by the DBMS manufactures). In comparison the server site uses relatively expensive tools. In addition the PC-based tools show good Rapid-Application-Development (RAD) qualities i.e. that simpler application can be produced in a comparatively short time. The two-tier model is the logical consequence of the RAD-tools' popularity.

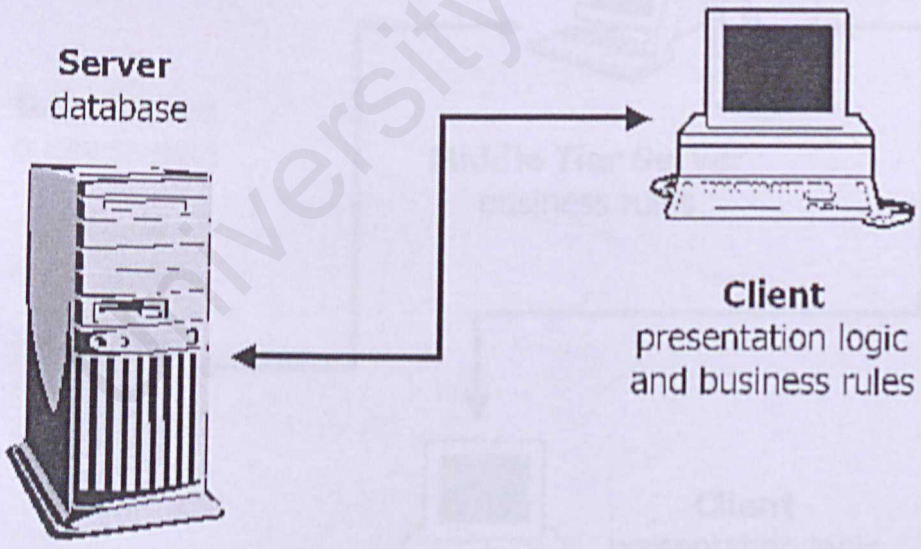


Figure 2.6: Two-tier Architecture

2.6.3 Three-tier Architecture

The two-tier model shows striking weaknesses such as application logic can't be reused because it is bound to an individual PC-program, fat clients, network overload since every data has to be transfer to client and etc. due to these facts, development and maintenance of such applications are much more expensive.

Three-tier architectures endeavor to solve these problems. This goal is achieved primarily by moving the application logic from the client back to the server. Three-tier architecture consists of three tiers, the client, the application server and the data-server as shown in Figure 2.7.

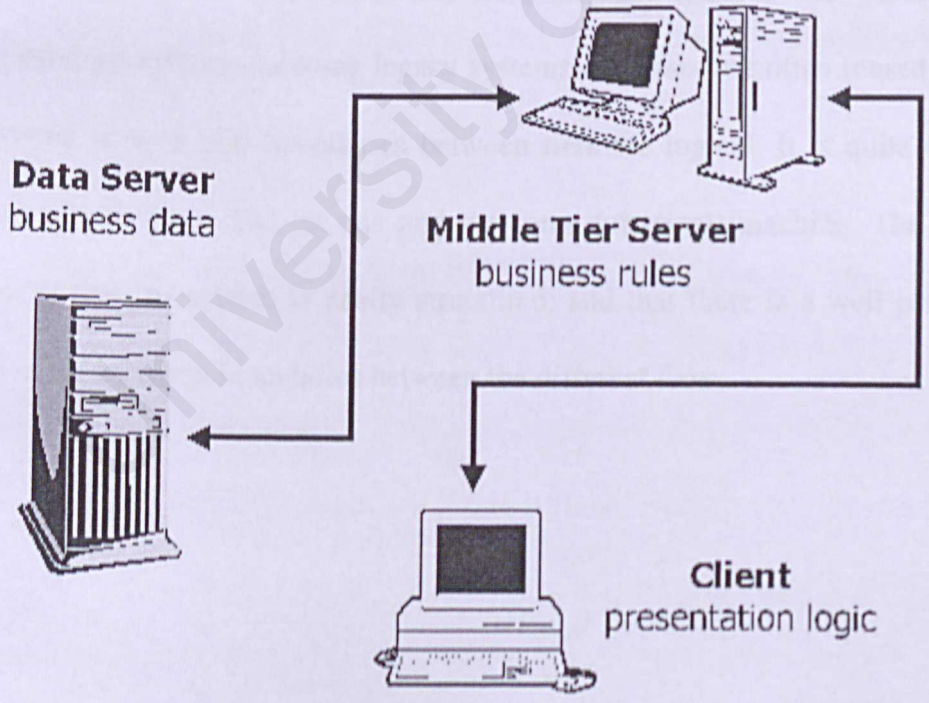


Figure 2.7: Three-tier Architecture

Client tier is responsible for the presentation of data, receiving user events and controlling the user interface. The actual business logic (for example, calculating added value tax) has been moved to an application-server.

Application-server-tier is new, i.e. it isn't present in two-tier architecture in this explicit form. Business-objects that implement the business rules "live" here, and are available to the client-tier. This level now forms the central key to solving two-tier problems. This tier protects the data from direct access by the clients.

Furthermore, the term "component" is also to be found here. Today the term pre-dominantly describe visual components on the client-side. In the non-visual area of the system, components on the server-side can be define as configurable objects, which can be put together to form new application processes.

Data-server-tier is responsible for data storage. Besides the widespread relational database systems, existing legacy systems databases are often reused here. It is important to note that boundaries between tiers are logical. It is quite easily possible to run all three tiers on one and the same (physical) machine. The main importance is that the system is neatly structured, and that there is a well planned definition of the software boundaries between the different tiers.

2.7 Analysis on Web Server

2.7.1 Personal Web Server (PWS)

PWS is entry-level/mid-range server for Windows 9x/NT platforms. It is a scaled-down version of the commercial Internet Information server (IIS) included with the server edition of Microsoft Windows NT. PWS is a great entry-level web server that makes it easy to publish personal home pages, serve small websites, and share documents via a local Intranet.

PWS is one of the best servers available for helping to get users up and running quickly. Wizards are included to guide users through the process of setting up home pages and sharing files, and the PWS administrator reduces the complexity of actually running the web server itself. Users can also use the familiar Explorer interface or PWS's Personal Web Manager to share directories, start and stop the server, and view web site statistics.

One of the best uses for PWS is as a platform for testing out web sites on Windows 95/Windows NT Workstation computers before hosting them on the Internet. This allows users to check the validity of links, scripts and applications as well as to ensure that the overall organization of the site is functioning correctly.

PWS presents the ability to develop transactional web applications using the Microsoft Transaction Server. Overall, while most large enterprises will likely bypass Microsoft Personal Web Server for the high-end Internet Information Server, PWS will remain one of the best available options for individuals wanting to serve their own personal homepages and for small organizations needing to host their own web sites.

2.7.2 Internet Information Server (IIS)

This version, which comes exclusively as part of the Windows 2000 Server operating system, contains many new features along with performance and reliability enhancements. Notable improvements include better and clearly documented security policies, support for the new WebDAV publishing standards and faster restarts of both Web and FTP services.

IIS v5.0 is good as both a fast time web server for those familiar and comfortable with Windows operating systems, and a high-end server for hosting provides and large corporate installations. It handles the basics well and is better integrated in Windows than previous versions. IIS v5.0 also comes with performance and feature enhancements that will be attractive for mission-critical tasks.

Microsoft has improved the clustering configuration and setup to enable multiple machines to share the load and deliver more reliable web services. However, it is still far from simple to set up. Enterprise must carefully review the documentation and copy various setting files using command line utilities supplied with Windows 2000 to set up a cluster. Such clusters are supported only by Advanced Server versions.

Version4 of IIS saw the beginning of Microsoft's Management Console to handle the configuration and setup of IIS. This has been extended to a variety odf other non-web services in Windows 2000 and renamed Computer Management, although for the most part, the screens will be familiar. New to IIS v5.0 are performance, application protection and tuning enhancements. However, the

documentation is inadequate to properly set up these new features without a lot of trial and error.

Microsoft has added a few new wizards to help simplify some common tasks. Three notable wizards are the Permissions Wizard (to synchronize and align web and NTFS security setting), the Web Server Certificate Wizard (to obtain and install server certificates) and the CTL Wizard (to create and modify certificate trust lists). Version 5 has various security enhancements as well. Microsoft has consolidated security tips in its documentation. Such tips include restricting guest accounts and setting appropriate file permissions. However, setting up client side certificates is still far too complex and poorly documented.

One of the more significant enhancements in IIS v5.0 is Web-based Distributed Authoring and Versioning (WeBDAV). WeBDAV is an emerging standard designed to simplify the construction of intranets and enable multiple users to publish documents to a common web server. This feature allows users to share web directories as if they were standard Windows files shares, using Office 2000 and IE v5tools running on Windows 98, NT and Windows 2000. Web DAV-enabled folders appear as "Web Folders" when users open files in Office 2000 from a remote web site. File locking is supported so more than one user cannot edit a file concurrently.

2.7.3 Apache

Apache remains the king of web servers despite intense effort by Microsoft and Netscape to gain dominance in the market. Apache users have to come to rely on the server's rock-solid reliability, outstanding performance and rich set of features. The keys to Apache's attractiveness and popularity lie instead in the qualities listed above and its extensibility, its freely distributed source code and active user support for the server.

Based originally on NCSA's freely available HTTP server, Apache's features and strengths are too numerous to list. Among the most notable features are its cross-platform support, protocol support (HTTP/1.1), modularity (API), security, logging and overall performance and robustness. Apache runs Windows (95/98/NT), OS/2 and all the major variants of UNIX. The server is fully compliant with HTTP/1.1 and supports API and ISAPI (NT). Apache distributes a core set of modules that handle everything from user authentication and cookies to typo correction in URLs.

Apache overall security, performance and robustness are unquestionable – many of the most accessed sites in the world run Apache or Apache derivatives. Public distribution of the source code results in patches for the software are promptly caught and reported. As a result, Apache's large user base has allowed its developers to create a package that is extremely stable and secure and one that is also able to compete more effectively with commercial packages in terms of both raw speed and integrated features.

Despite all of its strengths, Apache certainly is not for everybody. Setup and maintenance of the server are accomplished via command-line scripting tools. Unlike

most popular commercial servers, Apache offers neither browser-based maintenance capabilities nor any GUI configuration/administration tools. This is an advantage for some developers, but for others it can translate into higher deployment and maintenance costs, especially if the site's administrators are unfamiliar with the fundamentals of the server. Furthermore, Apache's "user-driven" technical support via newsgroup may not get the job done for more than a few developers. There are, however, several companies that do provide full commercial support but for a price.

The typical development and marketing style of the Apache server have not precluded it from becoming the most popular World Wide Web Server on the Internet today. Apache's robust design and extensibility, coupled with it freeware status and the availability of its source code to the public, make Apache a good choice for enterprise-level web sites and for individuals and workgroups that use UNIX or a combination of UNIX and NT platform.

2.8 Analysis on Database Server

2.8.1 Oracle 9.0

Oracle 9.0 server is a multi-user relational database management system (DBMS) that run on numerous operating systems. Oracle 9.0, the worlds most powerful object relational database is the heart of the open, standards-based Network Computing Architecture. Network Computing Architecture allows IT organizations to speed less time struggling with interoperability issues and more time focusing on deploying solutions. It provides unprecedented ease-of–use and is pre-turned and pre-configured for today's dynamic workgroup and line-of bus environment.

Oracle 9.0 includes fully integrated set of ease-to-use management tools, full distribution, replication and web features. Oracle 9.0 also provides the highest levels of availability through fast over, easier, management and zero data loss disaster protection, with Data Guard, the only complete data protection solution available on the market.

Oracle 9.0 delivers the entire major platform requires by network-based architecture which involve multiple hardware and software platforms, this includes UNIX, Linux and Windows platforms. However, it is expensive and separate licenses are required for each of its database engine. Oracle 9.0 data management, security, reliability and ease of use, is unique designed to meet the demands of the network era.

On the top of the feature of Oracle 9.0, it is known with it features such as security and compatibility. In the view of security, Oracle 9.0 has many level of security and has seamless integration with Windows NT, therefore provides security,

a web application environment. As for compatibility, Oracle 9.0 compatible with many operating systems and it has its own product line such as Portal-to-go, Java developer and others.

2.8.2 Microsoft Access 2000

Microsoft Access 2000 is a window-based database management system. It is a member of the Microsoft Office 2000 family and it runs under Windows 95/98/NT/2000 operating system. Due to the fact that Access is part of the Office 2000 suite, it interoperates well with the other components of the Office 2000 family.

Access is easily the world's most popular relational database management software (RDBMS). It is powerful and yet easy to use. With Access, the database administrator can design and use databases very quickly, as it has a very user-friendly interface. Furthermore, tables, forms, queries and reports can be generated just at a snap of a finger, just by using the set of wizards that come with this software. All this makes Access an excellent all-in-one database tool for creating standalone database application.

Microsoft Office provides a broad array of tools and technologies for creating multi-user database solutions. Specifically, Microsoft Access provides tools and features for creating multi-user database solutions by using four different database architectures that is file-server, client/server, replication and web-based data access pages.

2.8.3 SQL Server 2000

SQL Server is Microsoft's DBMS. It's highly scalable and user can use it to develop applications for everything from small networks to thousands of users. It is designed to meet requirement of a distributed client-server environment.

The SQL Server driver enables application to access data in Microsoft SQL Server database through the Open Database Connectivity (ODBC) interface. Structured Query Language (SQL) is used to access data in a SQL server database. All the client workstations communicate with SQL Server across a star network with TCP/IP protocol.

SQL Server 2000 extends the performance, reliability, quality, and ease-of-use of Microsoft SQL Server version 7.0. Microsoft SQL Server 2000 includes several new features that make it an excellent database platform for large-scale online transactional processing (OLTP), data warehousing, and e-commerce applications.

The OLAP Services feature available in SQL Server 7.0 is now called SQL Server 2000 Analysis Services. The term OLAP Services has been replaced with the term Analysis Services. Analysis Services also includes a new data mining component.

Below are the features of Microsoft SQL Server 2000:

- **Fully Web-Enabled**

SQL Server 2000 provides extensive database programming capabilities built on web standards. It is powerful, flexible and fully web-enabled analysis in manipulating data. Rich XML and internet standard support provide the ability to store, retrieve data in XML format easily with built-in stored procedures and insert, update and delete data easily.

- **Highly Scalable and Reliable**

Unparalleled scalability and reliability can be achieved using SQL Server 2000. With scale up and scale out capabilities, SQL Server meets the needs of demanding e-commerce and enterprise applications.

- **Simplify Management and Tuning**

SQL Server 2000 can easily manage database centrally alongside all enterprise resources and stay online while easily moving and copying database across computers or between instances.

2.9 Analysis on Operating System

2.9.1 Windows 2000 Professional

Microsoft Windows 2000 Professional was built on Windows NT technology with the user friendly, Windows 98 familiar user interface. It can be used for running software applications, connect to internet and intranet sites, and access files, printers, and network resources. Furthermore, it is the windows operating system for both

business laptop and desktop system. Microsoft Window 2000 Professional is known for its flexibility, manageability, reliability and its web capabilities.

The main reason of why considering Microsoft Windows 2000 Professional as the operating system is because of its strong development platform. One of the examples will be the telephony technologies in Windows 2000 Professional that developer can use to create custom applications. By using Windows 2000 Professional as the client, developer can built rich application with attributes that can be easily replicated and tested on multiple sites. Internet Explorer 5 support Dynamic HTML, DHTML behaviors and Extensible Markup Language (XML) enable developer to invent new ways to create, exchange and display information. When Windows 2000 Professional is combined with the integrated Web and communication services built into Windows 2000 Server, developers can create highly scalable, end-to-end e-commerce and line-of-business solutions.

Other features by Microsoft Windows 2000 Professional includes new peripheral support that extend notebook capabilities, modifications to the operating system core to prevent crashes and the ability for the operating system to repair itself, comprehensive security features to protect sensitive business data, both locally on desktop computer and as it is transmitted over local area network, phone lines, or the Internet. With its support for Internet-standard security features such as IP Security, Layer 2 Tunneling Protocol, and Virtual Private Networking it is so secure that many banks and organization choose to use it. Windows 2000 Professional is easier to deploy, manage, and support Centralized management utilities, troubleshooting tools, and support for self-healing applications.

When Windows 2000 Professional is used in conjunction with Windows 2000 Server, developer can take advantage of IntelliMirror technologies. By storing important information and desktop setting on a central computer, IntelliMirror lets developer work on any computer attached to the network as if they are at their own desk.

2.9.2 Windows 2000 Server

Windows 2000 Server is a multipurpose, entry level server operating system that can be used to provide the network users with files, print, application, or web services. Windows 2000 Server provides a well integrated package containing the application development environment, security, and scalability. With Windows 2000 Server, user gets all the usability features of Windows 2000 Professional, plus support for up to two multiprocessors for new installation and up to four multiprocessors when they upgrade for Windows NT 4.0.

As the server operating system built for the business Internet, Windows 2000 server lets user:

- Use the web to securely connect employees, customers and suppliers, anywhere in the world.
- Share select information without compromising confidential data.
- Expand the network environment as the application need evolve.
- Internet-enable business with essential technologies woven throughout the operating system.

- Cut costs with improved management systems for networks, servers and Windows desktops.
- Taking advantage of new hardware with broad support for existing and emerging hardware and communication products.

Windows 2000 Server provides comprehensive, standard-based security services, including flexible authentication, data encryption, flexible and secure network access, protection of virtual private networks (VPNs) using core Internet Standard such as IP security (IPSec), secure transaction processing and security extensions for the development platform such as the Crypto API.

Windows 2000 Server also introduce new technologies that let user build richer Web applications and solutions, such as the next generation of the Microsoft Component Object model, COM+. Developers using COM+ find it much easier to create and use software components and benefit from a runtime environment and services that are easily used for any programming language or tool.

Windows 2000 Server also includes integrated support for streaming media, which allows organizations to develop and distribute real-time presentations and rich multimedia content to both internal and external audiences.

2.10 Analysis on Programming Languages

2.10.1 Active Server Pages (ASP)

Active Server Pages or generally refer as the ASP are Microsoft's efforts of creating dynamic web pages. ASP pages are scripts or short snippets of code interpreted by the web server to perform a particular task. ASP pages contain two parts: programmatic code and embedded HTML. The programmatic code can be written in a number of scripting languages such as VBScript and Jscript.

ASP is implemented as an Internet Server Application Programming Interface (ISAPI) filter running under Internet Information Server (IIS). Whenever a Web client makes a HTTP request of a Web Server, the Active Server ISAPI filter gets a chance to intercept the request. If the request is for a .asp file, the ASP server takes over from IIS, parses the entire file from top to bottom, processes the server script(s) and returns an HTML output file to IIS. IIS will return this data stream to the requesting Web client.

ASP is able to deliver client/server side scripting, web controls, server side processing and connectivity features. It supports client side scripting such as Javascript that is executed at client's web browser. Apart from scripting ability, ASP act as an intermediate for Active X control, Java applet and others web component. ASP has the ability to tap into existing system such as databases, document retrieval services, mail services, Groupware servers and other COM-based information servers.

2.10.2 ASP.NET

ASP.NET is a programming framework built on the common language runtime that can be used on the server to build powerful Web applications. ASP.NET offers several important advantages over previous Web development models:

- **Enhanced Performance**

ASP.NET is compiled common language runtime code on the server. Unlike its interpreted predecessors, ASP.NET can take advantage of early binding, just-in-time compilation, native optimization and caching services right out of the box. This amounts to dramatically better performance before you ever write a line of code.

- **World-class Tool Support**

The ASP.NET framework is complemented by a rich toolbox and designer in the Visual Studio integrated development environment. WYCSIWYG editing, drag-and-drop server controls and automatic deployment are just a few of the features this powerful tool provides.

- **Power and Flexibility**

Because ASP.NET is based on the common language runtime, the power and flexibility of that entire platform is available to Web application developers. The .NET framework class library, Messaging and Data Access solutions are all seamlessly accessible from the Web. ASP.NET is also language-independent, so

you can choose the language that best applies to your application or partition your application across many languages. Further, common language runtime interoperability guarantees that your existing investment in COM-based development is preserved when migrating to ASP.NET.

- **Simplicity**

ASP.NET makes it easy to perform common task, from simple form submission and client authentication to deployment and site configuration. Additionally, the common language runtime simplifies development, with managed code services such as automatic reference counting and garbage collection.

- **Manageability**

ASP.NET employs a text-based, hierarchical configuration system, which simplifies applying setting to your server environment and Web applications. Because configuration information is stored as plain text, new setting may be applied without the aid of local administration tools. This "zero local administration" philosophy extends to deploying ASP.NET Framework as well. As ASP.NET Framework application is deployed to a server simply by copying the necessary files to the server. No server restart is required, even to deploy or replace running compiled code.

- **Scalability and Availability**

ASP.NET has been design with scalability in mind, with features specifically tailored to improve performance in clustered and multiprocessor environments. Further, processes are closely monitored and managed by the ASP.NET runtime, so that if one misbehaves (leaks, deadlocks), a new process can be created in its place, which helps keep the application constantly available to handle requests.

- **Customizability and Extensibility**

ASP.NET delivers a well-factored architecture that allows developers to "plug-in" their code at the appropriate level. In fact, it is possible to extend or replace any subcomponent of the ASP.NET runtime with your own custom-written component. Implementing custom authentication or state service has never been easier.

- **Security**

With built in Windows authentication and per-application configuration, you can be assured that your applications are secure.

2.11 Analysis on Data Access Techniques

2.11.1 Introduction to SQL and ODBC

SQL is a language used to create, manipulate, examine, and manage relational databases. A single statement can be very expressive and can initiate high-level actions, such as sorting and merging data because SQL is an application-specific language. SQL was standardized in 1992 so that a program could communicate with most database systems without having to change the SQL commands. Unfortunately, you must connect to a database before sending SQL commands, and each database vendor has a different interface, as well as different extensions of SQL. ODBC, a c-based interface to SQL-based database engines, provides a consistent interface for communicating with a database and for accessing database metadata. With QDBC and SQL, you can connect to a database and manipulate it in a standard way. It is no surprise that, although ODBC began as a PC standard, it has become nearly and industry standard.

2.11.2 ActiveX® Data Objects(ADO)

ActiveX® Data Objects (ADO) is an application program interface from Microsoft that lets a programmer writing Windows applications get access to a relational or non-relational database from both Microsoft and other database providers. ADO is designed to eventually replace *Data Access Objects (DAO)* and *Remote Data Objects (RDO).* Unlike RDO and DAO, which are designed only for accessing relational databases, ADO is more general and can be used to access all sorts of different types of data, including web pages, spreadsheets, and other types of

documents.

Like Microsoft's other system interfaces, ADO is an object-oriented programming interface. It is also part of an overall data access strategy from Microsoft called Universal Data Access.

Active Data Object (ADO) is the Microsoft's newest high-level interface for data objects that most applications developers will use. ADO provides consistent access to data for creating a front-end database client or middle-tier business object using an application, tool, language, or even an Internet browser. ADO is the single data interface for developers creating 1 to n-tier client/server and Web-based data-driven applications.

2.11.3 ADO.NET

ADO.NET is an evolutionary improvement from Microsoft® ActiveX® Data Objects (ADO) that provides platform interoperability and scalable data access. Using Extensible Markup Language (XML), ADO.NET can ensure the efficient transfer of data to any application on any platform. A major changes from ADO is that there is no Recordset object in the ADO.NET. Instead, a dataset is used in ADO.NET. Dataset class works as a central repository for tables of data, and also supports constraints and logical relations between tables. Furthermore, the Dataset object is a disconnected data container.

With Visual Studio.NET, developers program against objects, not tables and columns. ADO.NET features strongly typed programming, enabling developers to quickly write reliable data access code.

The centerpiece of any software solution using ADO.NET is the data set. A data set is an in-memory copy of database data. A data set contains any number of data tables, each of which typically corresponds to a database table or view. That is, it exists in memory within an active connection to a database containing the corresponding tables or views. This disconnected architecture enables greater scalability by only using database server resources when reading or writing from database.

At run time, data will be passed from the database to a middle-tier business object and then down to the user interface. To accommodate the exchange of data, ADO.NET uses an XML-based persistence and transmission format. To transmit data from one tier to another, an ADO.NET solution expresses the in-memory data (the data set) as XML and then sends the XML to the other component.

2.12 Analysis on Web Authoring Tools

2.12.1 Notepad

Notepad is the world's most versatile HTML editing tool. It is absolutely free with the purchase of Windows version 2.0 and above.

Notepad has one of the simplest user interfaces of any Internet Web authoring tools. The menus are logically laid out, conforming to all standards in design, so users can understand them before using the notepad.

Notepad has the same interface for all versions of Windows, so moving over to the latest version of Windows should not hamper HTML code creation. The Notepad web-authoring tool is compatible with every single standard of Internet presentation medium yet developed. Notepad was designed to have a very small application footprint, taking up as little space as possible in computer's memory, and a minimum of disk space.

Notepad gives clear, easy to read and full HTML. There is no code hidden, and users have control over all parts of the HTML code. JavaScript is also fully supported by Notepad. All parts of the JavaScript are fully available through Notepad, without the need of complex tools.

2.12.2 Microsoft Visual Studio.NET

Visual Studio .NET is a complete set of development tools for building ASP Web applications, XML Web services, desktop applications, and mobile applications. Visual Basic .NET, Visual C++ .NET, and Visual C# .NET all use the same integrated development environment (IDE), which allows to share tools and

facilitates in the creation of mixed-language solutions. In addition, these languages leverage the functionality of the .NET Framework, which provides access to key technologies that simplify the development of ASP Web applications and XML Web services.

Latest features available in this release of Visual Studio include:

(a) Language Enhancements

- Microsoft Visual Basic, Microsoft C++, and Microsoft JScript have all been updated to meet your development needs. Additionally, a new language, Microsoft C#, has been introduced. These languages leverage the functionality of the .NET Framework, which provides access to key technologies that simplify the development of ASP Web applications and XML Web services.

(b) Web Forms

- Web Forms are an ASP.NET technology that you use to create programmable Web pages. Web Forms render themselves as browser-compatible HTML and script, which allows any browser on any platform to view the pages. Using Web Forms, you create Web pages by dragging and dropping controls onto the designer and then adding code, similar to the way that you create Visual Basic forms.

(c) XML Web Services

- XML Web services are applications that can receive requests and data using XML over HTTP. XML Web services are not tied to a particular component technology or object-calling convention and can therefore be accessed by any language, component model, or operating system. In Visual Studio .NET, you can quickly create and include XML Web services using Visual Basic, Visual C#, JScript, Managed Extensions for C++, or ATL Server.

(d) XML Support

- Extensible Markup Language (XML) provides a method for describing structured data. XML is a subset of SGML that is optimized for delivery over the Web. The World Wide Web Consortium (W3C) defines XML standards so that structured data will be uniform and independent of applications. Visual Studio .NET fully supports XML, providing the XML Designer to make it easier to edit XML and create XML schemas.

2.12.3 Macromedia Dreamweaver

Macromedia Dreamweaver gives developers the productivity of a visual web page layout tool, the control of an HTML text, editor and support for new web technologies, all in one software packing.

Developers can use it to create web sites visually, with confidences that

HTML being generated is concise and always editable. It includes advanced features that take advantage of the latest innovations on the web, such as dynamic HTML and CSS, while still ensuring that web pages work well in a variety of web browsers. All of the code generated by it is carefully created to work on as many platforms and browsers as possible.

Others features include easy integration of Active X components, Java applets, Plug-ins for improved web page interactivity. It also integrates seamlessly with other components of Macromedia, such as Flash Movies, Shockwave, and Fireworks, which are essential for the development of interactive web pages.

2.12.4 Adobe Photoshop

Adobe Photoshop is used as drawing, painting and designing purposes. Users can retouch an image, apply special effects, swap details between photos, introduce text and logos, adjust color balance, and even add color to a grayscale scan. All these functions are included under a set of user-friendly editing tools in Adobe Photoshop. It contains graphical icons to represent every functions of each button. Besides that, it also provides many shortcut keys that is easier and save time for users and for those who do not like to use mouse.

CHAPTER 3

METHODOLOGY

3.1 System Development Life Cycle

System (software) development generally takes the form of a life cycle. We refer to this life cycle as the system development life cycle (SDLC). All systems go through the same generic stages in their lifetime. The stages are shown in the figure below.

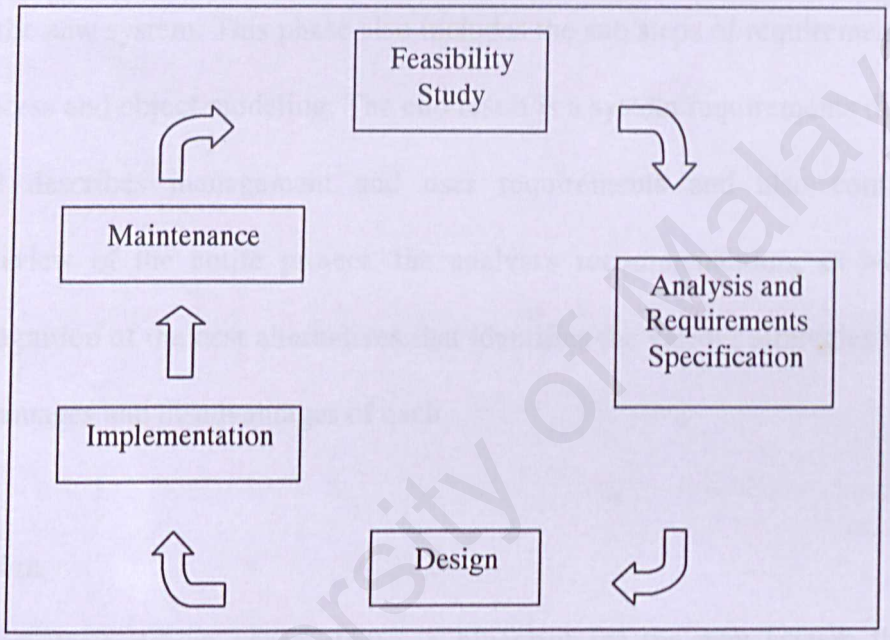


Figure3.1: System Development Life Cycle (SDLC) Stages

- **Feasibility Study**

This phase begins with a problem or desired change in an information system or business process. A preliminary investigation is then performed to clearly identify them. This step is crucial because if the business' needs are not correctly identified the end product will most certainly miss the mark. The end result of this phase is a report that illustrates business considerations with the

use of cost-benefit analysis and a proposal that is based on economic, technical and operational aspects.

- **Analysis And Requirements Specification**

  The main purpose of the systems analysis phase is to begin with a clear understanding of business requirements and build a logical, non-physical model of the new system. This phase also includes the sub steps of requirements, data, process and object modeling. The end result is a system requirements document that describes management and user requirements and also contains an overview of the entire project, the analyst's recommendation, as well as a recognition of the best alternatives that identifies the various strategies with the advantages and disadvantages of each.

- **Design**

  The systems design phase creates a blueprint for the new system that will satisfy all documented requirements, whether the system is being developed in-house or purchased as a package. The model that was built during the analysis phase is expanded in detail to include interfaces, the type of data input and output, the processes performed as well as backup and security measures. Once again the end result is documented. This time it comes in the form of a systems design specification report that is submitted to management and users for their appraisal.

- **Implementation**

  In the systems implementation phase the new system is constructed, programs are written, documented, and tested, and the system is installed. If the system was purchased as a package the analysts carry out any needed modifications and configure the system for use. The goal of this phase is to present a fully functioning and documented system, regardless of its origin, to train new users on and transition all of the old system's duties upon.

- **Maintenance**

  In the final phase, the IT staff maintains and enhances the system. The objective during this phase is to maximize return on the IT investment. Analysis is also very important during this phase. System performance and operation costs must be continually monitored to determine if the new system is really a worthwhile replacement.

3.2 System Development Methodology

A system development methodology is a very formal and precise system development process that defines a set of activities, methods, best practices, deliverables and automated tools for system developers to use to develop and maintain most of the systems or software. A system development methodology implements the development stage of the system life cycle and it helps to speed up and simplify software development process.

In developing a system, a methodology is needed to establish a style or procedure the way a system is developed from new. Even in the process of enhancing or amending an existing system, the need of methodology is also equivalent.

A methodology also helps to establish a consistency of approach. By following a selected methodology, a list of activities needed and order for the activities are needed. Besides that, it also helps to establish management controls by stating the milestones and the checkpoints of each component of the system.

Other than that, the usage of a methodology also encourages the quality of the product produced. This is because the product is sure to have satisfied milestones stated in all the components. Thus, this ensures the product quality. Methodology also satisfied the purpose of formalizing the requirements elicitation process to reduce the chances of misunderstanding the requirements. Besides that, it also introduces best practice techniques to the analysis and design process. The objectives of a methodology include the following:

- Provide a systematic method of development so that progress can be monitored.
- Produce a system that is well documented and easy to maintain.
- Provide an indication of needed changes as early as possible in the development process.
- Reduce the risk associated with shortcuts and mistakes.

There are many types of methodologies which can be use to design and develop a system or software. Among these are structured analysis and design, object oriented analysis and design (OOAD), rapid application development and etc. Structured analysis and design has been chosen as the methodology for this project.

3.2.1 Structured Analysis and Design Methodology

Structured Analysis and Design methodology (SSADM) was developed by Ed Yourdon in the early 1970's. Its principles focus on the analysis and design phases of the life cycle and allow the flexibility to return to earlier phases when necessary. This in turn reduces maintenance time, effort and expense.

Structured Analysis and Design is a type of structured methodology that based on modeling. In structured methodology, the whole system is view as a single function. This system is later decomposed into set of functions which will then be grouped according to hierarchy. It is actually a decomposition approach where a system is decomposed into several smaller modules.

The main aspect of Structured Analysis and Design methodology philosophy are user involvement, the three views, top-down approach and separation of logical and physical methods. This methodology covers most of the system development life cycle (SDLC) from the feasibility study to system design. The strategy planning is not part of Structured Analysis and Design methodology and it is to be carried out before a project is undertaken. This methodology also does not cover implementation and maintenance phases of the SDLC. However, it makes both implementation and

maintenance easier by providing accurate documentation of the system. Structured Analysis and Design methodology is based on the following hierarchy of activities : module, stage, step and task.

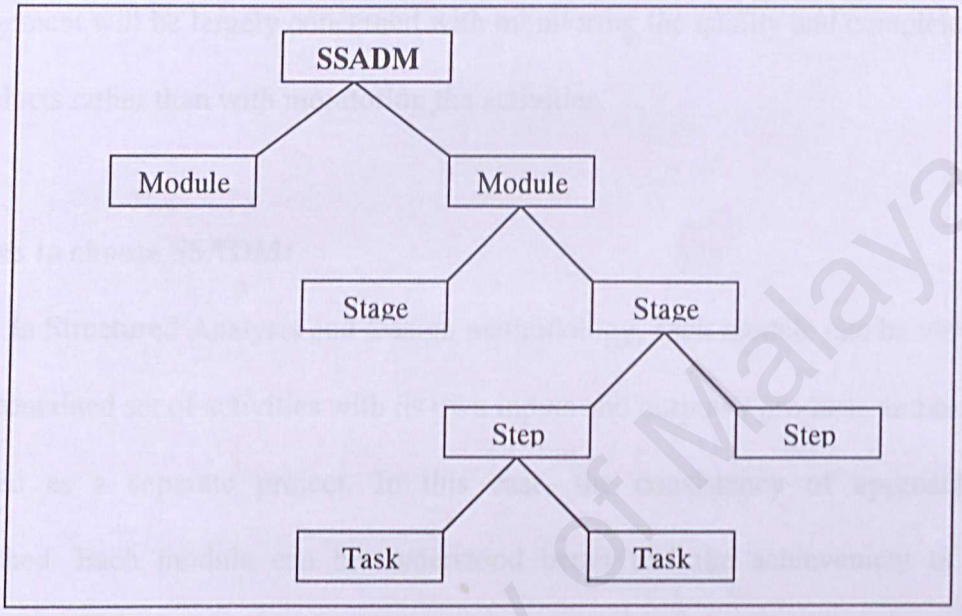


Figure 3.2: Hierarchy of Activities

There are five modules in this methodology:

- Feasibility analysis
- Requirements analysis
- Requirements specification
- Logical system specification
- Physical design

Every stage is divided into steps and each set is presented as a set of tasks, all of which are numbered for easy identification. Moreover, every step is thoroughly

described both in terms of the activities that are to be carried as well as products, which are the result of the activity. Each step is associated with a number of techniques and tools, which the developer should use to model the system. Structured Analysis and Design methodology is thus product-driven. Project management will be largely concerned with monitoring the quality and completeness of products rather than with monitoring the activities.

Reasons to choose SSADM:

In Structured Analysis and Design methodology, each module can be view as a self-contained set of activities with its own inputs and outputs / products and can be managed as a separate project. In this case, the consistency of approach is established. Each module can be understood better and the achievement of the milestone stated for each module can be clearly evaluated.

In addition, Structured Analysis and Design methodology adopts a prescriptive approach to information system development in that it specifies in advance the modules, stages, steps and tasks that have to be carried out, the deliverables produced and the techniques involved. Thus, SSADM can helps to overcome the chance that requirements are misunderstood. Besides that, this methodology also helps to overcome the problems concerning limited user involvement and the usage of inadequate analysis and design tools and techniques.

3.3 System Development Process Model

One of the underlying principles for system development methodology is the establishment of phases and activities. All life cycle methodologies prescribe phases and activities. However, the number and scope of phases and activities varies. In order to illustrate and document a system development process for a particular methodology, a specific 'tool' known as software process model has been used as an abstract representation of a software process. After reviewing several process model such as waterfall model, V model, unified process model and etc, waterfall model with prototyping has been chosen as the working model of the proposed system.

3.3.1 Waterfall Model with Prototyping

Waterfall model with prototyping is considered the most suitable process model for this project as it is comply with the chosen system development methodology. Prototyping model is added into the selected waterfall model due to the benefits that revisions and modification not necessarily have to be carried out at the testing phase. Thus this can help to save a lot of time and effort in making any necessary amendments.

The waterfall model was derived from engineering models to put some order in the development of large software products. It consists of different stages, which are processed in a linear fashion. Compared to other software process models it is more rigid and better manageable. The waterfall model is an important model, which is the basis of many other models.

The software development process can help to control the thrashing by including activities and sub process that enhance understanding. Prototyping is such a sub process: a prototype is a partially developed product that enables customers and developers to examine some aspect of the proposed system and decide if it is suitable or appropriate for the finished product. For example, developers may build a system to implement a small portion of some key requirements to ensure that the requirements are consistent, feasible and practical: if not, revisions are made at the requirement stage, rather than at the more costly testing stage. Similarly, parts of the design may be prototyped, as shown in figure 3.3. Design prototyping helps developers assess alternative design strategies and decide which is best of a particular system or software development.

There are usually six stages in this model of software development:

1. **Requirements Analysis and definition**

In this stage the requirements of the "to be developed software" are established. These are usually the services it will provide, its constraints and the goals of the software. Once these are established they have to be defined in such a way that they are usable in the next stage. A feasibility study is often included in this stage.

2. **System Design**

Once the requirements are defined, a system design has to be created. This stage involves outlining system functional by having feasibility studies or case studies on current system, determining and specifying hardware or software architecture and

verifying system design. System design involves describing the software system appearance and functionality from the user's perspective.

3. Program Design

From the information of researches and studies, program design is start to be determined and specified. Database design and program design verification also carried out at this stage.

4. Coding

This stage translates and implements the detail design representation of the system into programming realization. It involves programming, personal planning, tool acquisition, database development, component level documentation and programming management.

5. Unit and Integration Testing

Testing is a critical step in assuring the quality of the developed system and will represent the ultimate review of specification, design and coding. After units are developed, units are tested separately and by different categories of users. Integration testing is then performed. It is to integrate unit-tested program modules and conduct tests that uncover errors or bugs associated with the interfacing of those modules. Validation test succeeds when the system functions in the manner that is reasonably expected.

6. **System Testing**

All the integrated units are combined into a system and now the whole is tested. When the combined programs are successfully tested the software product is finished.

- **Validation**

  It ensures that the system has implemented all of the requirements, so that each system function can be tracked back to a particular requirement in the specification. And makes sure that the deliverables satisfy requirements specified in the previous stage or an earlier stage, and that the business case is met.

- **Verification**

  It ensures that each function works correctly, checks the quality of the implementation and checks that a deliverable is complete (contains all requires information, follows standards).

7. **Acceptance Testing**

Testing on system completed. The system is delivered.

8. **Operation and Maintenance**

Most software products include this stage of the development. It involves correcting errors that have gone undetected before, improvement and other forms of support. This stage is part of the life cycle of a software product, and not of the strict

development, although improvements and fixes can still be considered as "development".

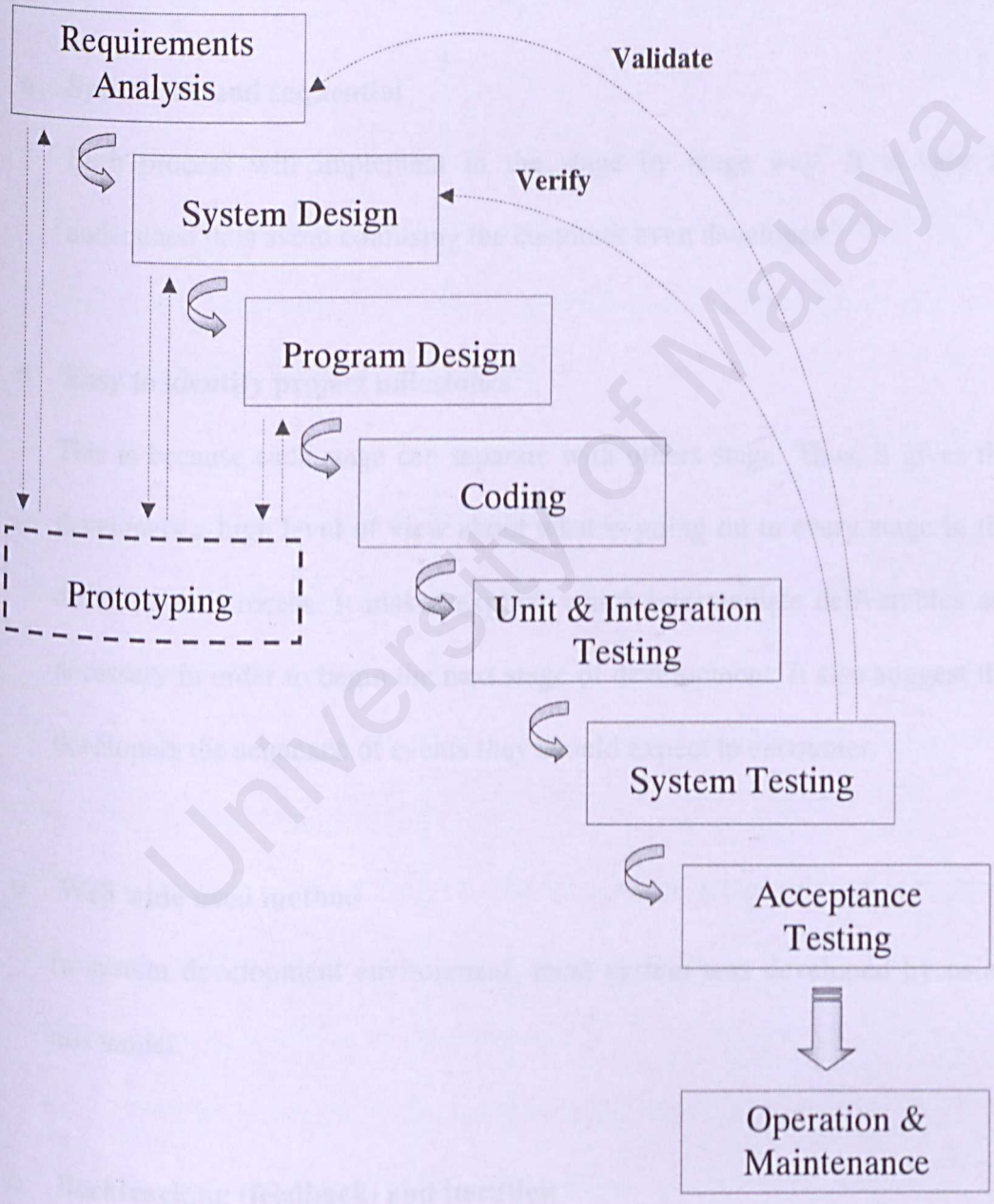


Figure 3.3: Waterfall Model with Prototyping

3.3.1.1 Strengths of Waterfall Model With Prototyping

Waterfall model with prototyping is the extension from waterfall model. It is one of most popular in system development environment. This is because it provided many benefits to developer. Below are strengths of this model.

- **Systematic and sequential**

  Each process will implement in the stage by stage way. It is easy to understand thus avoid confusing the customer even developer.

- **Easy to identify project milestones**

  This is because each stage can separate with others stage. Thus, it gives the developers a high level of view about what is going on in every stage in the development process. It makes explicit which intermediate deliverables are necessary in order to begin the next stage of development. It also suggest the developers the sequence of events they should expect to encounter.

- **Well wide used method**

  In system development environment, most system was developed by using this model.

- **Backtracking (feedback) and iteration**

  The package has circulation factors so it allows changes in previous phase even through we are not in the current phase. In other words, iteration is

enabling in the sense that developers can move back and forth between stages. This can be applied for requirement analysis, system design and program design stage. In the traditional waterfall model, after the developers moved to a specific stage, they cannot move back to the previous stage and this is not very practical in actual development process.

- **Advantages of prototyping**

  It can ensure the system meets the performance goals or constraints. Beside that, it also can ensure the system is practical and flexible. It also can ensure the system fulfill the users' requirement.

Reasons to choose Waterfall Model With Prototyping :

- It is simple and suitable for system with shorter time from requirements to product completion.
- It allows backtracking and iteration in order to accommodate any changes that may occur during system development
- It is easy to identify deliverables or milestone for each stage which will allow better management for activities of the following stage.
- Various advantages offered by prototyping
  - enables errors and weaknesses to be detected earlier
  - ensures the system meet the performance goals or constraint
  - ensures the system fulfills the users' requirements

- promotes understanding of interaction between modules and sub-modules.

As Field Service System is developed to overcome the weaknesses of the current field service management system, user requirements are very essential. Prototyping is very useful in the sense that it helps to elicit and clarify the user requirements for the proposed system.

CHAPTER 4

SYSTEM ANALYSIS

4.1 Introduction

A good software development practice start with a good system analysis. Before developing a system, the objective of the system must be understood first, by eliciting the functional and non-functional requirements of the system. After understanding the requirements thoroughly, analysis is conducted to choose the appropriate tools, architecture, model or techniques to develop a good system. This phase involves all the activities necessary to determine system requirements. According to Kendall & Kendall, a requirement is a feature of the system or the description of something the system is capable of doing in order to fulfill the system's purpose. Requirements are divided into two categories: functional and non-functional requirements.

4.2 Functional Requirements

A functional requirement describes an interaction between the system and its environment. It also describes how the system should behave when given a certain stimuli. Functional requirements are statements of services the Field Service System should provide, how the system should react to particular inputs and how the system should behave in particular situation. The functional requirements stated below could be categorized into five distinct sections that are customer service call module, user management module, sales management module, technician module and technical manager module.

4.2.1 Login Module

This module allows different level of user access to the Field Service System via a valid userID and password. It will include features like enable users to change their password, which is an essential functionality in user account management.

a) System access

- User shall be able to access to the system via login by using a valid user ID and password.
- If user entered a wrong ID or password, system shall be able to generate an appropriate message that informs the user regarding this matter.
- The system shall be able to direct a user to the right function after the authentication process by generating different system view for different level of user.
- User shall be able to logout securely from the system.

b) Change password

- The system shall allow user to change password upon his / her request.

4.2.2 Service Call Management Module

This module is prepared for customers which allows them to request for service and check the service status through Internet. It will also provide customer with the choice to view for the contract details.

a) Service request

- Customer shall be able to place a service order at anytime where they are allowed to report their problems using the web form.
- The system shall be able to generate and assign a unique service number for a particular service order from the customer.

b) Order status

- Customer shall be able to view the reported problem or service order that already placed.
- Customer shall be able to check the status of service order from time to time.

b) Contract and product details

- The system shall allow a customer to view and check his/her personal details.
- The system shall allow a customer to view details in a contract (service agreement made between a customer and the company). These include information such as contract period, list of products under preventive maintenance and etc.

4.2.3 User Management Module

User management module is prepared mainly for system administrator to manage all the details of a system's user. These include employee profile and customer profile.

a) Employee profile

- System administrator shall be able to view all the employee's details such as type, IC number, contact number and etc. The system shall be able to generate and display different employee's list based on the user selection. For example, by employee's type.
- System administrator shall be able to edit/modify an existing employee's record except some fields such as employee ID.
- System administrator shall be able to add a new employee's record.
- System administrator shall be able to delete an existing employee's record when it is no longer available.

b) Customer's profile

- System administrator shall be able to view all the customer's details such as location, type, contact number and etc. The system shall be able to generate and display different customer list based on the user selection. For example, by customer's type.

4.2.4 Sales Management Module

Sales management module is prepared mainly for Sales and Marketing personnel to manage all the details or information related to a customer. These include customer profile, product sold to a customer and service agreement between a customer and the company.

a) Customer profile

- Sales and Marketing personnel shall be able to view all the customer's details such as location, type, contact number and etc. The system shall be able to generate and display different customer list based on the user selection. For example, by customer's type.
- Sales and Marketing personnel shall be able to edit/modify an existing customer's record except some fields such as customer ID.
- Sales and Marketing personnel shall be able to add a new customer's record.
- Sales and Marketing personnel shall be able to delete/deactivate an existing customer's record when it is no longer available.

b) Customer's product

- Sales and Marketing personnel shall be able to view all the products sold to a particular customer. This includes the product's part number, serial number, period of warranty and etc.
- Sales and Marketing personnel shall be able to edit/modify any product for a particular customer. For example, when there is a change occurs on period of warranty for a product, the system shall allow authorized personnel to update the data.
- Sales and Marketing personnel shall be able to add new product(s) for a particular customer.
- Sales and Marketing personnel shall be able to delete any product for a particular customer.

c) Contract management

- The system shall be able to display the list of all the customer's contract in different order based on the user selection.
- Sales and Marketing personnel shall be able to view the details of a customer's contract such as contract period, date of service, list of products under preventive maintenance and etc. Sales and Marketing personnel shall be able to edit/modify an existing service agreement.
- Sales and Marketing personnel shall be able to add new contract for a particular customer. The system shall enable authorized user to attach product(s) to a new contract when it is created.
- Sales and Marketing personnel shall be able to delete/deactivate an existing service agreement when it is no longer available.

d) Parts management

- The system shall allow user to view the parts details and its availability especially for the technicians and technical manager.
- Sales and Marketing personnel shall be able to edit/modify any part information.

4.2.5 Dispatch Management Module

Dispatch management module is prepared for technical manager to manage service orders, create work orders, dispatch and schedule technicians to jobs. Various reports can also be generated. The functions that are included in this module are:

a) Work order listing

The work order list brings the list of current work orders directly to the technical manager in a list format. It provides an easy way for the technical manager to view at selective technician, or all technicians and selective work order status.

- The technical manager shall be able to see work order listing allocated to a particular technician or elect to see work order that have particular status. (i.e unassigned, awaiting parts etc).
- The technical manager shall be able to convert new service order to work order.
- Service order details shall be viewed in complete details by clicking on a service order no in the list.

b) Schedule

The dispatch screen offers a visual and graphical representation of technician's workload and schedules. Each work order is represented on the dispatch screen in a row and column format. It helps the technical manager to efficiently assign technicians to the right jobs with information on their current schedule and availability.

- The technical manager shall be able to view at the work orders that are displayed graphically in a row and column format on the schedule with summarizes information such as service order no, assigned time and date.
- The technical manager shall be able to assign or reassign work order to the appropriate technician.

C) PREVENTIVE MAINTENANCE MANAGEMENT

Preventive maintenance enables the technical manager to manage the details of the service agreement, ensuring the rights parts, the right technician are in the right place at the right time.

- The technical manager shall be able to view the list of all upcoming service agreement by month.
- The technical manager shall be able to view each customer's preventive maintenance contract. This is to ensure that contract obligations are delivered.
- The technical manager shall be able to convert the preventive maintenance into work order.

d) Customer qualification

Customer qualification allows the technical manager to view the "big picture" of a particular customer who request for service order.

- The technical manager shall be able to view at the customer's information of each work order in the work order listing which includes information about the customer's location, required service descriptions, date and time received of each service order.
- The technical manager shall be able to check details of customer's warranty/service agreement coverage.
- The technical manager shall be able to view all the products installed at the customer's location.

f) Report generator

Various reports can be generated to help the technical manager to see how service operation is functioning.

- The technical manager shall be able to view closed work order report by month and year.
- The technical manager shall be able to view technician productivity report, category service rate report during the selected month and year.

4.2.6 Work Order Management Module

Work order management module is prepared to help technician better prepare for work order by providing technician access to essential/necessary customer, service and product information for each work order that is assigned to them. Thus, technician will be able to concentrate on executing jobs rather than gathering customer details. A technician could check their jobs on a web browser at the start of the day, plan their day's travel and workload, and then at the end of the day, enter the work done and the parts used straight into the system. The functions that are included in this module are:

a) Work order schedule

Work order schedule is provided for the technician to access and keep track of their daily jobs schedule. Technician can only view their personal schedule.

- The technician shall be able to view the listing of his/her daily work order schedule.

- The work order schedule shall be arranged according to date in an ascending order.
- The technician shall be able to change the status of each work order (i.e in progress, awaiting parts, completed etc).

b) Work order details

The system provides the technician with customer's information that is only relevant to the work order so that they do not have to search through a mountain of information for some simple data.

- The technician shall be able to view the details information of each work order on the work order schedule screen. The information includes customer's information, description of the service call, date and time of the work order being assigned.
- The technician shall be able to view the service history that has been performed at the customer's location. This information is sorted in date order, with the most recent information displayed first. This screen shows the description of the service history, the problems and the resolutions

c) Parts availability

The system provides the technician with parts status and parts availability data in real time.

- Technician shall be able to check for the availability of parts by category.

d) Service report

Closed work order report forms are common after each service order is completed. It is best to implement it electronically as the data can be stored for easy retrieval later on and it helps to maintain detailed service history for reference later.

- The technician shall be able to fill out the details description of the work done, start work date and time, closed date and time and total hours and minutes spent on the work order.
- The technician shall be able to change the status of the completed work order to "completed".
- The technician shall be able to claim for allowances such as overtime, mileage claims etc for each work order.

e) Solutions reference

When work is done, the technicians have to enter what was done in the service report. By allowing all work to be searchable, it provides an easy way to search knowledge and a way to encourage the sharing of knowledge by the technicians.

- The technician shall be able to search for past solutions as reference by category.

4.3 Non-Functional Requirements

Non-functional requirement is essential definition of the system properties and constraints under which a system must operate. It is a description of other features, characteristics, and constraints that define a satisfactory system. Mostly system users might expect certain degree of non-functional requirement. Some of the non-functional requirements for Field Service System are:

a) User-friendliness

For a system to be popularized, it must be easily understood by the users. The users need not know what happen behind the system but through the system's user interface, users are supposed to get whatever they want easily. Below are some 'scheme's provided to measure whether a system is user friendly or else:

- Consistent, in terms of screen design and error messages displayed.
- Accommodation of any level of user. It must be user friendly to all target users, the students, teachers as well as the parents.
- High degree of understandability and avoid too much of memorization of events and commands for the users.

b) Reliability

A system is reliable if it does not produce dangerous or costly failures in the typical user environment and data integrity is preserved. This definition recognizes that a system may not always be used in ways of which its designer expects. Field Service System must be a reliable system in providing services accurately and accessible at all time as the technical manager will have to schedule and the

technician must be able to access the appropriate customer's information at the right time.

c) Correctness

A program or system must operate correctly or it provides little value to its users. Correctness is the degree to which the software performs its required function. To ensure this application quality, lots of testing and trial-and-errors will be carried out.

d) Efficiency

A system is said to fulfill the efficiency requirement when its process or procedure can be called, accessed and functioning well to produce outcomes or output at a pace or speed acceptable by the users. Field Service System must be able to provide short loading time and respond time (more critical if the system is online). Slow loading and respond time might cause the users to wait and discourage them from using the system again. Response time in retrieving information such as view service order status, generating reports and view work order's information should be within a reasonable time interval.

e) Modularity

Modularity means the system is broken into small modules so that distinct functions of objects could be isolated from one to another other. This will make the system testing and maintenance process easier because the processes can be done

portion by portion and not involving the whole system. In Filed Service System, modularity of program module is applied as this will lead to easy modification in future.

f) Maintainability

This may be defined qualitatively as the ease with which software can be understood, corrected, adapted and enhanced. A product is maintainable if the programs are easily modified and tested in the case of updating a process to meet a new requirement, correcting errors, or move to a different computer system.

g) Functionality

The functionalities stressed here are the searching and retrieving capability, which is very important in any web applications that deal with data retrieval from existing database. Besides, navigation and browsing features as well as application domain-related features will be taken into account. FSS should be operating successfully according to client's specifications. Information in the FSS must be up to date so that the system serves its purpose in providing correct and up to date work order information and status to the technical manager or technician.

h) Security

User must login with their correct user ID and password to prevent unauthorized access into the system. Different level of user will have different system view.

4.4 Development Requirements

4.4.1 Development Side Hardware Requirements

The hardware requirements for the system's development environment are as stated in Table 4.1 below:

Table 4.1: Development Side Hardware Requirements

Hardware Components	Requirements
Processor	IBM compatible PC with a Pentium 4 processor or higher
Memory	192 MB of RAM or higher (256MB recommended)
Hard Disk	6 GB of hard disk space or higher
Monitor	SVGA or other compatible monitor
Input Devices	Keyboard, mouse or other compatible pointing devices.
Others	- 3 ½ " floppy disk drive - CD-ROM - Modem and Network Card - Sound Card

4.4.2 Development Side Software Requirements

The software requirements for the system's development environment are as stated in Table 4.2 below:

Table 4.2: Development Side Software Requirements

Software Components	Requirements
Operating System	Microsoft Windows 2000 Professional
Web Server	Internet Information Server (IIS)
Database Server	Microsoft SQL server 2000
Authoring Tool	Microsoft Visual Studio.NET
Development Language	ASP.NET
Data Access Technique	ADO.NET
Web Browser	Internet Explorer 6.0
Graphics Design Tool	Photoshop Adobe 5.5 or higher

a) Development Platform – Microsoft Windows 2000 Professional

Why choose this operating system?

- Microsoft Windows 2000 Server has been around for quite some time, most users, including those are not technically sound, are familiar with it.

b) Development Web Server - Microsoft Internet Information Services

Why choose this web server?

- Internet Information Services (IIS) is the Windows component that makes it easy to publish information and bring business applications to the Web.
- IIS makes it easy for you to create a strong platform for network applications and communications.

c) Database management system - Microsoft SQL Server 2000

Why choose this database server?

- SQL Server provides powerful and scalable support for large database and complex queries.
- Features provided by SQL Server ensure easy-to-use for database administrators in building, managing and deploying business applications.
- The data transformation services make it easy to import, export and transform heterogeneous data using OLE Database, Open Database Connectivity (ODBC) or text-only files.

d) Development Language – ASP.NET

Why choose this Language?

- Better Language Support
- Programmable Controls
- Event Driven Programming
- User Authentication, with Accounts and Roles
- Higher Scalability
- Increased Performance - Compiled Code
- Easier Configuration and Deployment

4.5 Client-Server System Requirements

4.5.1 Client System Requirements

Table 4.3: Client Hardware Requirements

Hardware Component	Requirements
Processor	Intel Pentium II/AMD 200Mhz minimum
Memory	64 MB RAM
Other Related Devices	Compatible Graphic Card, Compatible Sound Card, 56K Modem/ compatible Network Interface Card, Macromedia Plug-in

Table 4.4: Client Software Requirements

Software Components	Requirements
Operating System	Windows 95/98/ME/2000/NT
Internet Browser	Internet Explorer v 5 or other compatible browsers.

4.5.2 Server Systems Requirements

Table 4.5: Server Hardware Requirements

Hardware Component	Requirements
Processor	Intel Pentium III 450 MHz / AMD 450 MHz processor or above
Memory	128 Mb of RAM or higher
Hard Disk Space	Minimum of 6GB of Hard Disk Space
Other Computer Devices	Compatible Sound Card, Graphic Card, Network Interface Card , Macromedia Plug-in

Table 4.6: Server Software Requirements

Software Components	Requirements
Operating System	Windows 2000
Web Server	Microsoft IIS
Database Server	Microsoft SQL Server 2000
Internet Browser	Internet Explorer v 5 or other compatible browsers.

CHAPTER 5

SYSTEM DESIGN

5.1 Introduction

System Design is the creative process of transforming the problem into a solution; the description of solution is also called design. System design in an Information Technology environment context would not a complete success if there does not exist an understanding between the thinking complexities of the developer during the development of a system. This thinking complexity processes involve identifying goals, alternatives of strategic steps during processes such as design, making decisions and solving problems.

System Design also is a phase of the waterfall that the entire requirements for the system are translated into system characteristics. The requirements for system are regarding to the analysis that had been discussed in the previous chapter. System design includes the following issues:

- System Architecture Design
- System Functionality Design
- Database Design
- User Interface Design

5.2 Overview of System Architecture

The system architecture is based on the traditional client-server architecture. Basically, the software system is broken down into 3 tiers; the Presentation -tier, business-tier and database-tier.

The Presentation-tier deals with the presentation of the system to the end user. This part is web-enabled and is developed using ASP.NET. Development in this section involves work in Web design, Web authoring and web programming. The business-tier does the processing behind the scenes. This part applies the business rules and formatting to the data that is to be sent to the presentation layer. The database-tier accesses the database to read or write data. This tier deals with all the connectivity with the database.

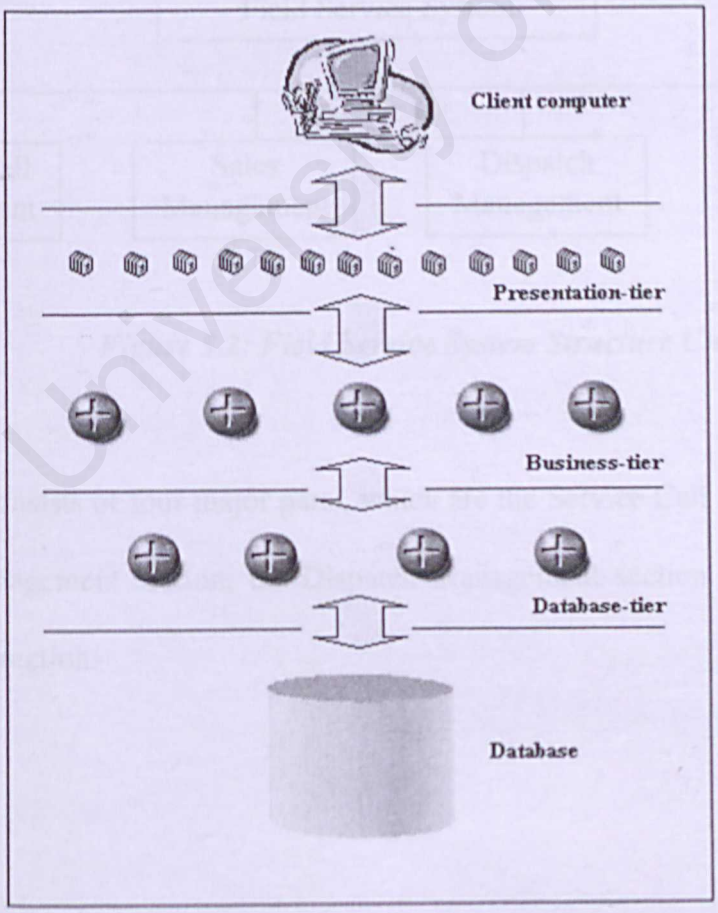


Figure 5.1: System Architecture

5.3 System Functionality Design

5.3.1 System Structure Charts

A large system can be decomposed into sub systems that provide some related set of services. Thus, this system structuring is the initial design process of identifying these sub systems and establishing a framework for sub systems control and communication. Structure charts is used to depict the high level extraction of a specification system. The usage of structure chart is to describe the interaction between independent sub systems.

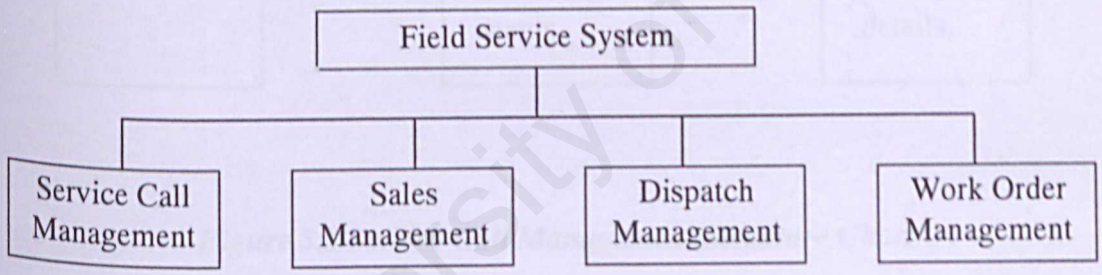


Figure 5.2: Field Service System Structure Chart

FSS consists of four major parts, which are the Service Call Management section, the sales Management section, the Dispatch Management section and the Work Order Management section.

Basically, the Service Call Management section is to let the customers to place service order where they can request service for the purchased product(s). They can check for the service status of the reported problem. Besides that, it also enables customers to view the contract details and product details.

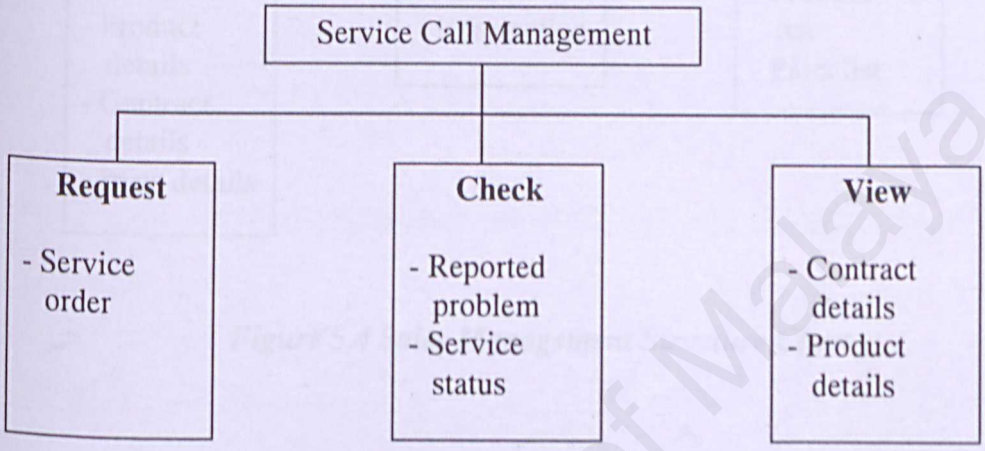


Figure 5.3 Service Call Management Structure Chart

In Sales Management section, Sales and Marketing can view and check all the customers' data and parts information. These include customer profile, product sold to a customer, service agreement between a customer and the company and parts details for the company products. It also lets the Sales and Marketing manages this information where authorized personnel can add, modify and delete / deactivate any piece of customer data and parts information.

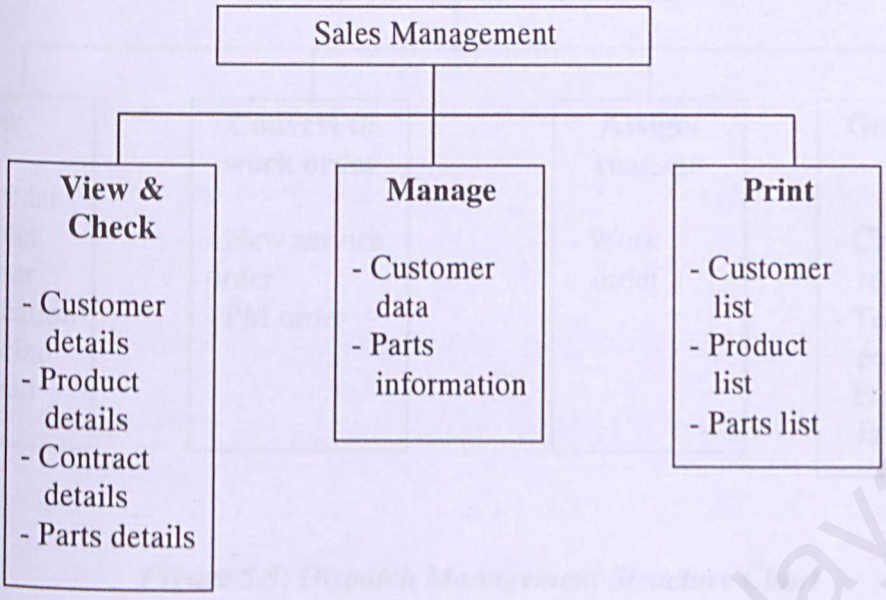


Figure 5.4 Sales Management Structure Chart

In Dispatch Management section, technical manager can view the new service order, work order and its details. Technical manager can converted new service order and upcoming preventive maintenance order to work order. Besides that, technical manager can also view technician's workload and availability in graphical representation and assign/reassign work order to the suitable technicians. The dispatch management section also let the technical manager check and view the details information of the customers which include warranty/contract details. In this section, various reports will also be generated.

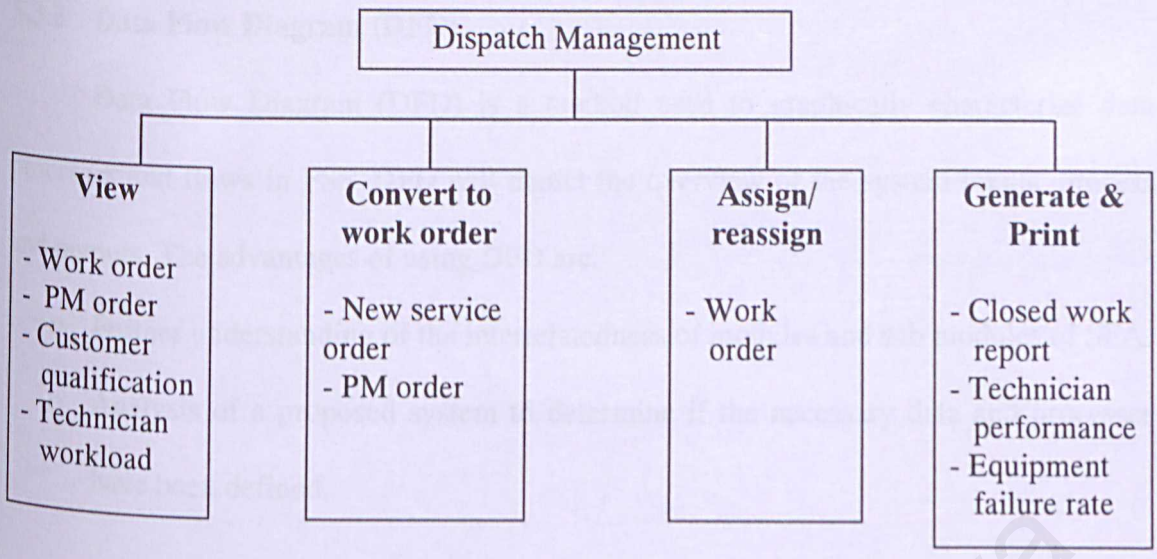


Figure 5.5: Dispatch Management Structure Chart

In the work order management section, technician can check their daily schedule. The technician can view the relevant information regarding each work order that is assigned to them. Besides that, it also let the technician search for the past service solutions as reference and check for parts availability. The technician can submit closed work order and expense claims.

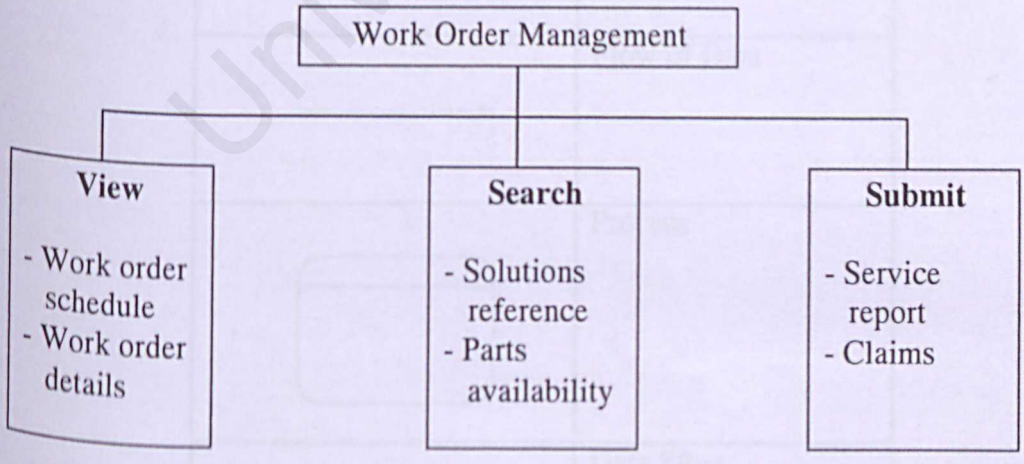


Figure 5.6: Work Order Management Structure Chart

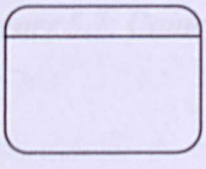
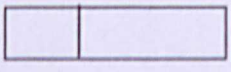
5.3.2 Data Flow Diagram (DFD)

Data Flow Diagram (DFD) is a method used to graphically characterize data processes and flows in FSS. DFD will depict the overview of the system inputs, process and outputs. The advantages of using DFD are:

- Further understanding of the interrelatedness of modules and sub modules of SFA.
- Analysis of a proposed system to determine if the necessary data and processes have been defined.

DFD is easy to be understood as it has symbols that specify the physical aspects of implementation. There four basic symbols in DFD: entity, flow of data, process and data stores.

Table 5.1: DFD Symbols

Symbols	Attribute
	Entity
	Flow of Data
	Process
	Data Store

The convention, which is used to design DFD are based on the work by C.Gane and T.Sarson. The data flow is conceptualized with a top-down perspective. So, the Context level Diagram will be drawn, followed by the Diagram 0. Diagram 0 is an overview process of all the major modules in FSS that includes all the data stores, entities and process involved.

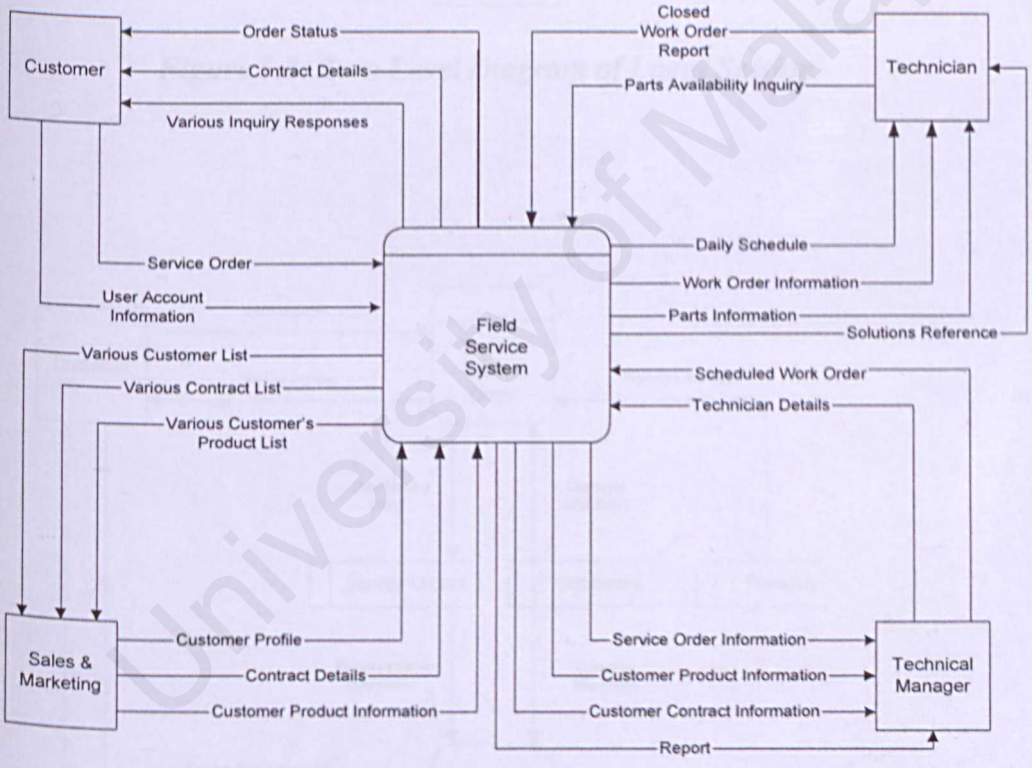


Figure 5.7: Context Level Diagram of FSS

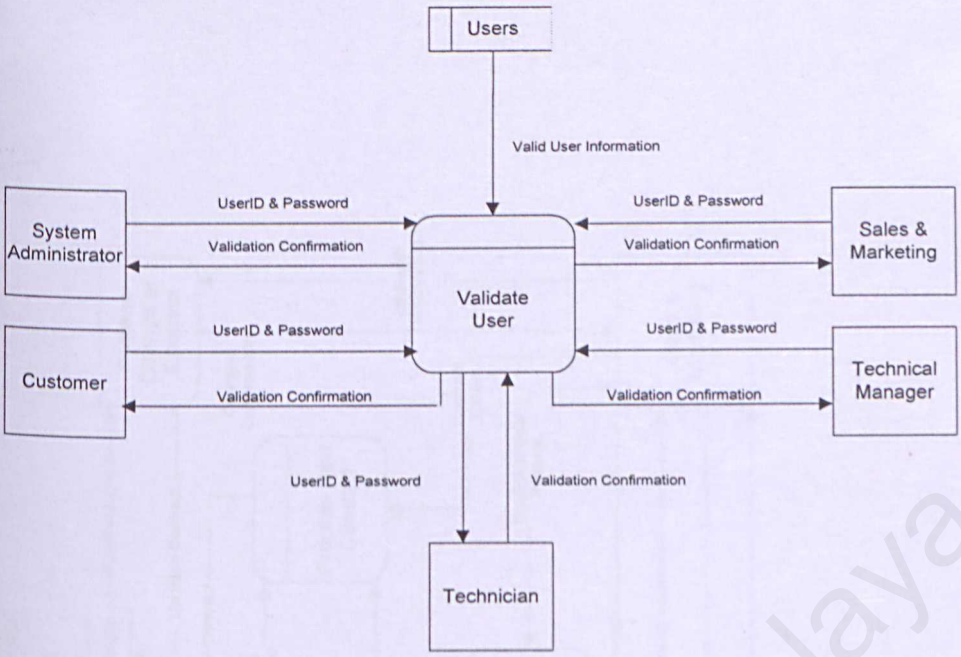


Figure 5.8: Zero Level Diagram of Login Section

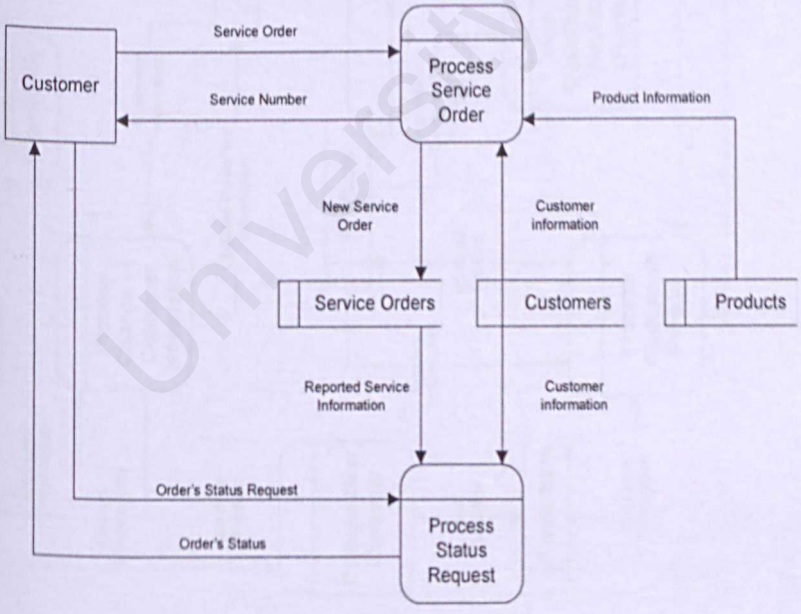


Figure 5.9: Zero Level Diagram of Service Call Management Section

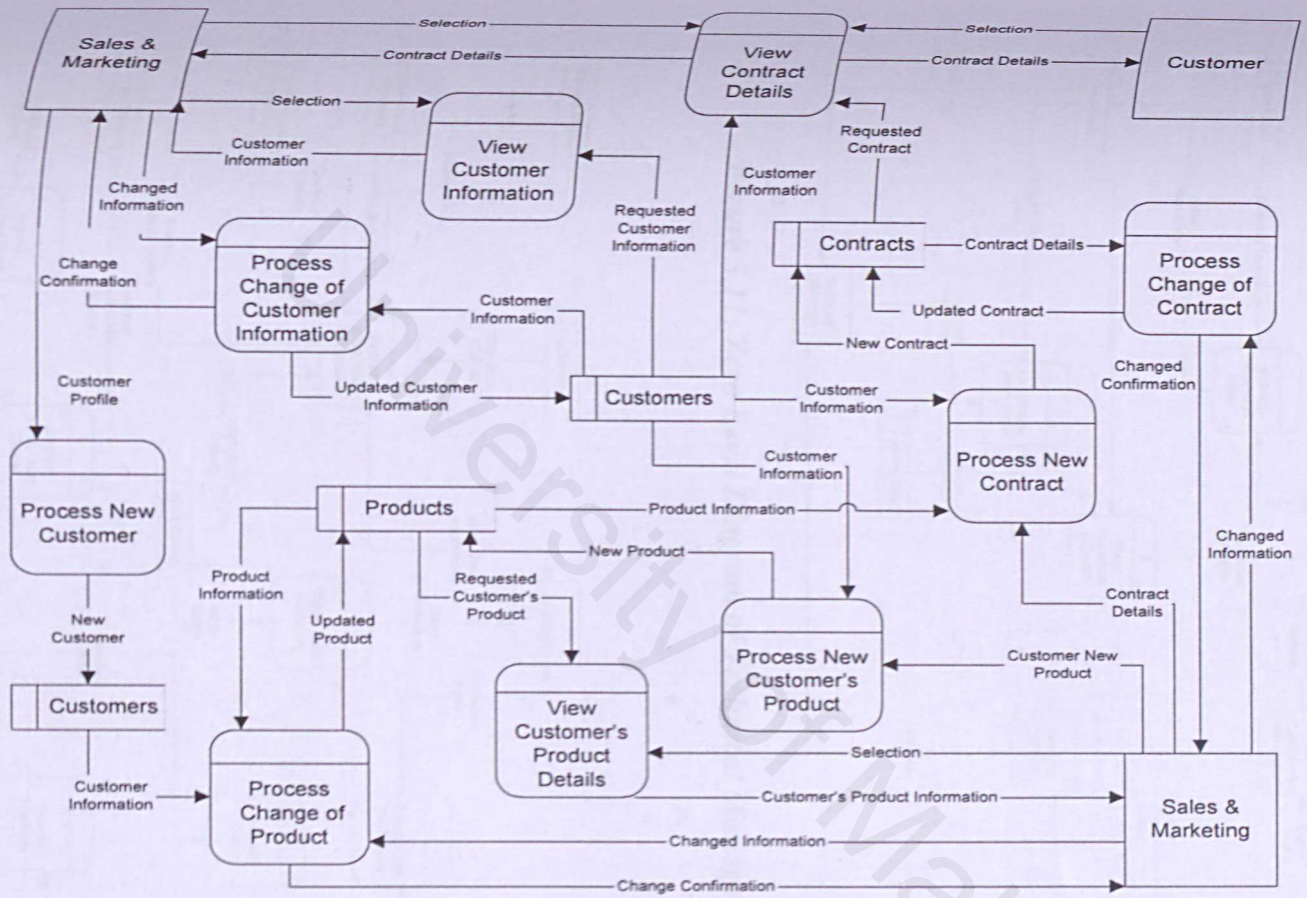


Figure 5.10: Zero Level Diagram of Sales Management Section

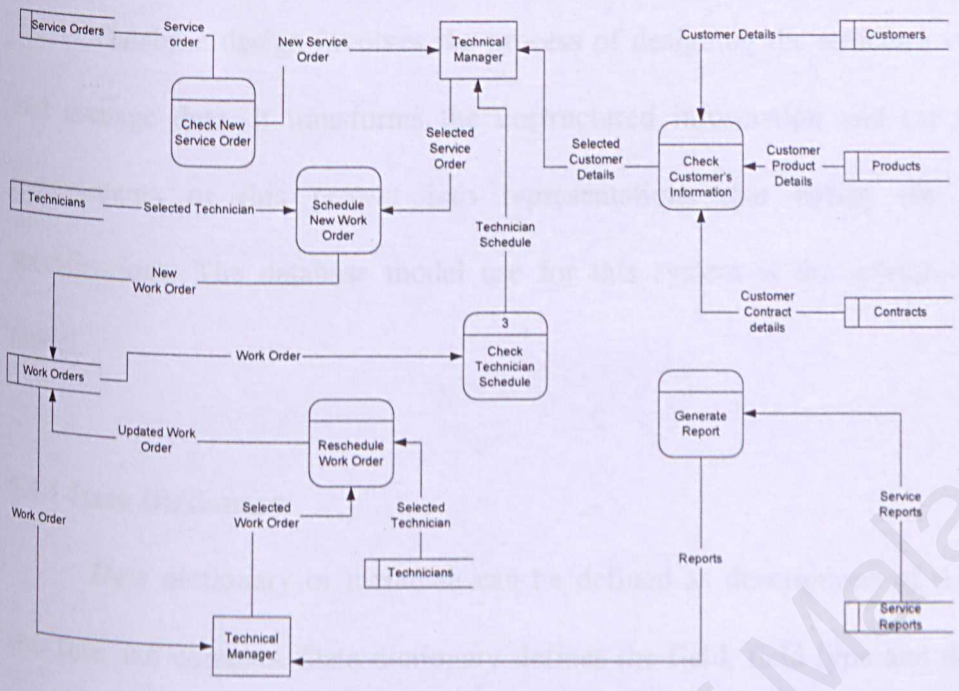


Figure 5.11: Zero Level Diagram of Technical Manager Section

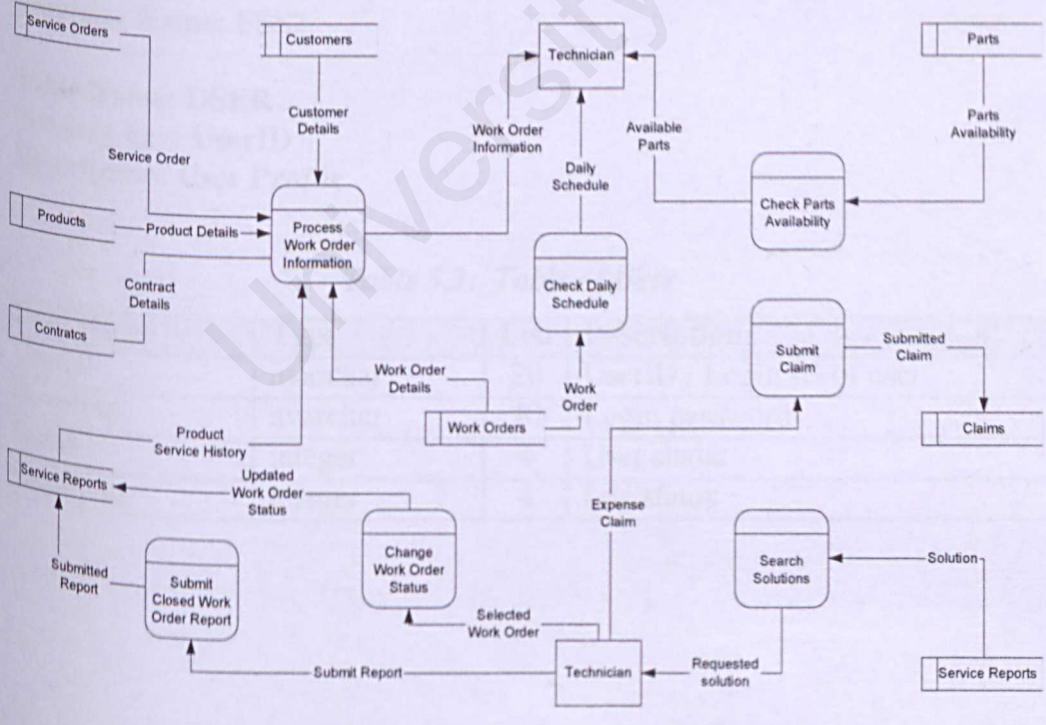


Figure 5.12: Zero Level Diagram of Technician Section

5.4 Database Design

Database design involves the process of designing the structure use to store and manage data. It transforms the unstructured information and the processing requirements of this project into representations that define the functional specifications. The database model use for this system is the relational database model.

5.4.1 Data Dictionary

Data dictionary or metadata can be defined as descriptions of the database structure and contents. Data dictionary defines the field, field type and descriptions of each table.

Database Name: FSS2

Table Name: USER
Primary key: UserID
Description: User Profile

Table 5.2: Table of User

Field Name	Type	Len	Description
UserID	nvarchar	20	UserID / Login ID of user
Password	nvarchar	10	Login password
Status	integer	4	User status
LogStatus	integer	4	Log status

Table Name: EMP_STATUS
Primary key: Status
Description: Employee Status

Table 5.3: Table of Employee Status

Field Name	Type	Len	Description
Status	integer	4	Status number
Status_Descrip	nvarchar	50	Status description

Table Name: CUSTOMER
Primary key: Cus_ID
Description: Customer Profile

Table 5.4: Table of Customer

Field Name	Type	Len	Description
Cus_ID	nvarchar	20	Customer ID
Cus_Name	nvarchar	50	Customer name / company
Cus_ContactName	nvarchar	30	Contact person
Cus_ContactTitle	nvarchar	30	Contact person's title
Cus_Address	nvarchar	80	Customer location
Cus_City	nvarchar	15	City
Cus_State	integer	4	State
Cus_Zip	nvarchar	10	Postal Code
Cus_Country	nvarchar	15	Country
Cus_Phone	nvarchar	24	Phone Number
Cus_Fax	nvarchar	24	Fax Number
Cus_Email	nvarchar	50	Email
Cus_Type	integer	4	Customer type
Cus_Ctr	integer	4	Customer with/without contract

Table Name: CUS_TYPE
Primary key: Cus_Type
Description: Customer type

Table 5.5: Table of Customer Type

Field Name	Type	Len	Description
Cus_Type	integer	4	Customer type no
Type_Descrip	nvarchar	50	Customer type description

Table Name: STATE
Primary key: State_no
Description: State in Malaysia

Table 5.6: Table of State

Field Name	Type	Len	Description
State_No	integer	4	State number
State_Descrip	nvarchar	50	State name

Table Name: PRODUCT
Primary key: Pro_No
Description: Product sold to customer

Table 5.7: Table of Customer's Product

Field Name	Type	Len	Description
Pro_No	nvarchar	20	Product number
Pro_Descrip	nvarchar	100	Product description
Pro_Quatity	integer	4	Quantity of product
Pro_InstallDate	datetime	8	Product install date
Pro_WarrantyPeriod	integer	4	Duration of warranty for product
Pro_Cus_ID	nvarchar	20	Cus_ID
Pro_Ctr_No	nvarchar	20	Ctr_No
Pro_Status	integer	4	Product status
Pro_Ctr_Desc	nvarchar	80	Product contract description
Pro_Remark	nvarchar	50	Product's remark
Pro_EndDate	datetime	8	Product warranty end date

Table Name: CONTRACT
Primary key: Ctr_No
Description: Service agreement between customer and company

Table 5.8: Table of Contract

Field Name	Type	Len	Description
Ctr_No	nvarchar	20	Contract number
Ctr_Period	nvarchar	20	Duration of a contract
Ctr_StartDate	datetime	8	Contract start date
Ctr_LastUpdateDate	datetime	8	Last renew date for a contract
Ctr_EndDate	datetime	8	Contract end date
Ctr_ServiceDate	datetime	8	Date to provide service for customer
Ctr_Amount	nvarchar	10	Amount paid by customer for a contract
Ctr_Cus_ID	nvarchar	20	Cus_ID
Ctr_Status	integer	4	Contract status
Ctr_ServiceStatus	char	10	Contract service status

Table Name: SERVICE_ORDER
Primary key: Svc_No
Description: Service Order

Table 5.9: Table of Service Order

Field Name	Type	Len	Description
Svc_No	nvarchar	20	Service number
Svc_Priority	nvarchar	20	Level of urgency
Svc_Problems	nvarchar	100	Problems related to product reported by customer
Svc_Date	datetime	8	Date of service request
Svc_Time	datetime	8	Time of service request
Svc_Status	integer	4	Status_No
Svc_Cus_ID	nvarchar	20	Cus_ID
Svc_Ctr_No	nvarchar	20	Ctr_No
Svc_Type	integer	4	Service type
Svc_Pro_No	nvarchar	20	Pro_No

Table Name: SERVICE_TYPE
Primary key: SvcType_No
Description: Service type

Table 5.10: Table of Service Type

Field Name	Type	Len	Description
SvcType_No	integer	4	Service type no
SvcType_Name	nvarchar	50	Service type description

Table Name: STATUS
Primary key: Status_No
Description: Status

Table 5.11: Table of Status

Field Name	Type	Len	Description
Status_No	integer	4	Status number
Status_Name	nvarchar	50	Status name

Table Name: PART
Primary key: Part_No
Description: Product's Parts / Component

Table 5.12: Table of Part

Field Name	Type	Len	Description
Part_No	nvarchar	20	Part number
Part_Model	nvarchar	10	Part model
Part_Descrip	nvarchar	100	Description of part
Part_Quatity	integer	4	Quantity of available part
Part_Category	integer	4	Part category

Table Name: PART_CATEGORY
Primary key: Category_No
Description: Part Category

Table 5.13: Table of **Part Category**

Field Name	Type	Len	Description
Category_No	integer	4	Category number
Category_Desc	nvarchar	50	Category description

Table Name: EMPLOYEE
Primary key: Emp_ID
Description: Employee

Table 5.14: Table of Employee

Field Name	Type	Len	Description
Emp_ID	nvarchar	20	UserID
Emp_Name	nvarchar	50	Employee's name
Emp_Initials	char	10	Employee's initials
Emp_Gender	nvarchar	10	Employee's gender
Emp_IC	nvarchar	15	Employee's IC
Emp_Add	nvarchar	80	Employee's address
Emp_Zip	nvarchar	10	Employee's address postcode
Emp_City	nvarchar	20	Employee's address city
Emp_State	integer	4	Employee's address state
Emp_Country	nvarchar	50	Employee's address country
Emp_Phone	nvarchar	15	Employee's house phone number
Emp_Mobile	nvarchar	15	Employee's hand phone number
Emp_Email	nvarchar	30	Employee's email address
Emp_Status	integer	4	Employee's role

Table Name:WORK_ORDER
Primary key: WO_No
Description: Work Order

Table 5.15: Table of Work Order

Field Name	Type	Len	Description
WO_No	integer	4	Work order number
WO_Date	datetime	8	Work order start date
WO_Time	datetime	8	Work order start time
WO_DispNotes	nvarchar	200	Technical manager's notes
WO_Status	integer	4	Work order status
WO_SvcNo	nvarchar	20	Svc_No
WO_TechID	nvarchar	20	Tech_ID

Table Name: SERVICE_REPORT
Primary key: SvcRep_No
Description: Service Report

Table 5.16: Table of Service Report

Field Name	Type	Len	Description
SvcRep_No	integer	4	Service report number
SvcRep_CompleteDate	datetime	8	Work order complete date
SvcRep_CompleteTime	datetime	8	Work order complete time
SvcRep_TotalHour	integer	4	Total hour to complete work order
SvcRep_TotalMin	integer	4	Total minutes to complete work order
SvcRep_Category	integer	4	Category_No
SvcRep_Title	nvarchar	100	Service report's title
SvcRep_Des	nvarchar	1000	Description of resolutions
SvcRep_Status	integer	4	Status_No
SvcRep_SvcNo	nvarchar	20	Svc_No
AvcRep_TechID	nvarchar	20	Tech_ID

Table Name: CATEGORY
Primary key: Category_No
Description: Service Report Category

Table 5.17: Table of Service Report Category

Field Name	Type	Len	Description
Category_No	integer	4	Service report category number
Category_Desc	nvarchar	50	Service report category description

Table Name: CLAIM
Primary key: Cl_No
Description: Claim

Table 5.18: Table of Claim

Field Name	Type	Len	Description
Cl_No	nvarchar	30	Claim Number
Cl_Category	integer	4	Claim's category
Cl_Date	datetime	8	Date of claim
Cl_Hour	nvarchar	8	Total hour of claim
Cl_Min	nvarchar	8	Total minute of claim
Cl_Total	float	8	Total amount of claim
Cl_ReceiptNo	nvarchar	30	Receipt Number
Cl_SvcRepNo	integer	4	SvcRep_No
Cl_SvcNo	nvarchar	20	Svc_No
Cl_TechID	nvarchar	20	Emp_ID

Table Name: CLAIM_CATEGORY
Primary key: Claim_No
Description: Claim Category

Table 5.19: Table of Claim Category

Field Name	Type	Len	Description
Claim_No	integer	4	Claim number
Claim_Name	nvarchar	50	Claim description

Table Name: MONTH
Primary key: Month_No
Description: Month

Table 5.20: Table of Month

Field Name	Type	Len	Description
Month_No	integer	4	Month number
Month_Name	nvarchar	50	Month name

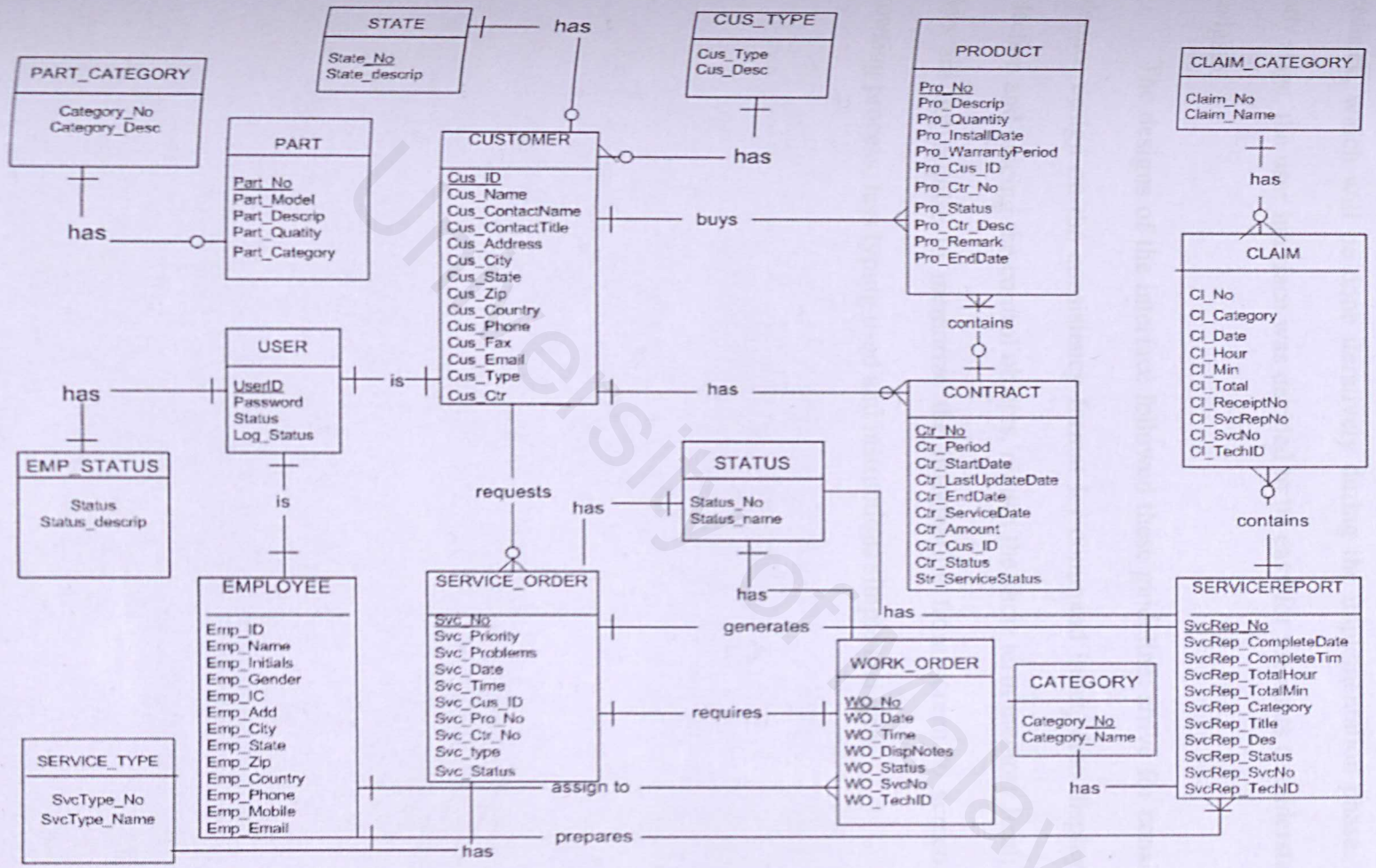


Figure 5.13: Entity Relationship Diagram of FSS

5.4 User Interface Design

A definite interface will only emerge after some degree of modification and feedback, which will be done iteratively during the implementation phase. At this early stage, the user interface was decided to be easy for the users to understand and navigate.

The designs of the interface followed these guideline: strive for consistency; interface design on the consistency format for command input, date display, menu selection and placing the control objects, reduce the short term memory load; system users are not require to memorize the information from screen to screen during browsing process, less typing used and instructions simple and easy.

CHAPTER 6

SYSTEM IMPLEMENTATION

6.1 Introduction

System implementation is a process that converts the system requirements into program codes. This phase also describes how the initial and revised process design put into the real work. Therefore system implementation involved the translation of the software representation produced by the design into a computer readable form.

For FSS, system implementation involved the system development environment, program coding and database implementation. Generally, the process involved are installing Windows NT 2000 Professional Edition, installing Microsoft SQL Server 2000, installing IIS (Internet Information Server), system programming using ASP.NET, JavaScript and HTML, debugging and testing. At the same times it also involved some modifications to the previous design due to the change of system requirements. Each module in FSS was developed separately and was integrated into a fully functional system once every module has been tested completely.

6.1.1 Development Tools

The basic development tools used in developing the Field Service System are as shown in table below:

Table 6.1: Basic Development Tools

Operating System	Microsoft Windows 2000
Database Management System	Microsoft SQL Server 2000
Web Server	Internet Information Server (IIS)
Web Authoring Tool	Microsoft Visual Studio.NET

Graphics Design Tool	Adobe Photoshop v7.0
Web Browser	Microsoft Internet Explorer 6.0

6.2 Development of Field Service System

6.2.1 Database Implementation

Microsoft SQL Server 2000 is the backend for the Field Service System (FSS). It hosts the FSS database which is the data source for the whole application. The database is built according to the system requirements as depicted in system design.

Manipulating data in the database is the most crucial part in FSS development, as almost every process occurs within the application deals with data in the database. ADO.NET (data access strategy) has been used to manipulate the data stored in SQL Server 2000. ADO.NET contains many classes that ease the process of building dynamic web application.

In ADO.NET, different type of database has to be accessed using its own data providers. A data provider in the .NET framework serves as a bridge between an application and a data source. A data provider is used to retrieve data from a data source and to reconcile changes to that data back to the data source. Since the SQL Server data providers only talks to Microsoft Server version 7 or higher, it's optimized and extremely fast. Thus, SQL Server has been used as the data provider for the FSS database. This provider is located in the System.Data.SqlClient namespace and provides classes for working with SQL Server 7.0 (or later)

databases. It contains the SqlConnection, SQLCommand, SqlDataReader and SqlDataAdapter classes.

In order to access to the database, connection need to be created between the application and the FSS database. For this project, database connection string was specified in the Web.Config file. This eliminates the need to include the connection string in every code behind page. The steps below show how to use the Connection object to build the connection to the FSS database.

1. Specify the connection string in the Web.Config file
2. Import the namespace and create a new database connection in the code behind page

```
<appSettings>
<add key="dbconn" value="Data Source=localhost; Initial Catalog=FSS;
        User Id=sa; Password=fieldservice"/>
</appSettings>
```

Figure 6.1: Database Connection String

```
Imports System.Data
Imports System.Data.SqlClient

Dim SqlConn as New

SqlConnection(ConfigurationSetting.AppSettings("dbconn"))
```

Figure 6.2: New Database Connection

After the connection has been established, various functions could be performed. For example, user is able to read the records, find and filter specific

records, update data as well as create or delete records. The ADO.NET command object contains the command (usually a SQL statement) we want to apply to the database.

There are different methods of the command object that the author uses to execute the command. ExecuteReader is use to return a DataReader object when returning results as a stream of data. ExecuteScalar is use to return a singleton value while ExecuteNonQuery is use to execute command where no results are returned.

```
Dim conn As New
SqlConnection(ConfigurationSettings.AppSettings("dbconn"))

Dim strqry As String
strqry = "DELETE FROM [PRODUCT] WHERE Pro_No='" & Select_Pro & "'"

Dim cmd As New SqlCommand(strqry, conn)
conn.Open()

Try
  cmd.ExecuteNonQuery()
Finally
  conn.Close()
End Try
```

Figure 6.3: Using the Command Object and ExecuteNonQuery Method

Besides the data reader objects, the DataSet object is also used in database manipulation. Unlike the data reader, command, and connection objects that are discussed above, datasets are not data provider-dependent. The DataSet is a memory-resident representation of data that provides a consistent relational programming regardless of the data source. A data adapter is an object that handles the process of filling the DataSet with data from a database.

```
Dim SqlConn As New
SqlConnection(ConfigurationSettings.AppSettings("dbconn"))

Dim strqry As String
strqry = "SELECT * FROM [CUS_TYPE]"

Dim adCus As New SqlDataAdapter(strqry, conn)
Dim dsCus As New DataSet

adCus.Fill(dsCus, "Type")
DDType.DataSource = dsCus.Tables("Type")
DDType.DataBind()
conn.Close()
```

Figure 6.4: Using the DataSet

For testing purpose, some dummy data were entered into the database during the development of Field Service System. Those data are needed to trace and debug the written codes.

6.2.2 System Coding

System coding comprising software programming and preliminary testing of the prototype model, convert the prior system design into a working and functional system through the defined computer-readable source codes. Programming transforms the structure charts, logical and physical data flow diagrams as well as interface design into working prototype model. Both processing and testing should occur in parallel when this process happens. The testing done in this phase is the development testing. The preliminary testing is important in that it helps to correct the individual module and the integration of multiple modules of the prototype model.

A flexible and understandable program code is essential for testing and

maintenance. To implement good programming algorithm and style become a very significant part of the project because it may cater for future enhancement. A flexible program can also be recycled.

6.2.2.1 Coding Approach

The proposed system is developed using both structural and modular programming where some modules are completed using top-down approach and others are completed using bottom-up approach.

Structural programming extends the principles governing structured design to the writing of the program. It is also based on the principles of the modularization that follows from the top-down development. Structure is a method of organizing and coding program that simplifies control path so that the program can be easily understood and modified. Structure programming reduces complexity created when program jump forward and backward to other parts of the program, obscuring the logic and flow of the program.

Modular programming is defined as breaking the application into well-defined, logical and manageable modules. By breaking the programming part, the bottom-up approach reduces the complexity of the system as well as making the development much easier. Sub modules are first developed, integrated later into larger modules only when all the sub modules have been tested to be working and functioning as required. The process will continue and ends when the overall system is modeled.

The whole FSS was divided into smaller modular part according to

functionality and each module was developed individually. These was then integrate together to form the FSS in whole.

6.2.2.2 Coding Principles

Good coding practices are essential to keep the proposed system consistent, maintainable and readable. By practicing good coding, the program written will be much clearer and more understandable. The following section discusses some of the important coding principles implemented in the FSS development :

a) Indenting, formatting and commenting the code to increase the program's code readability.
b) Using a variable naming convention consistently to increase the program's consistency and maintainability.
c) Using sub function at the code behind, include file and user control (file.ascx) to allow certain procedures available to many ASP.NET files and HTML page. It eases the messy work of correcting all ASP.NET pages when making changes on the procedures. This ensures the system maintainability.

6.2.3 ASP.NET Application

In Visual Studio.NET, developing web application involves building, processing and debugging web forms (ASP.NET pages) in a continuous basis. Different methods can be used to structure a web form, either by using scripting block or code behind. For the former, ASP.NET codes are written in script blocks, at

the top of an .aspx file, separated from the HTML code. For the latter, ASP.Net codes are not included in the .aspx file, but are moved to a code behind page (.aspx.vb). The author has used the second method in developing the system.

6.2.3.1 Web Form

A web form is an .aspx page that contains mainly the HTML code with combination of ASP.NET web controls. Development stage of FSS involves designing and creating multiple web forms. For example, in the Sales Management Module of FSS, form use to add a new part is created through the use of the various HTML elements and web controls. Tables are inserted and carefully align to suit the outlook of the information inside a form. Appropriate formatting is also applied in order to get a better layout. Figure below shows the partial codes found in AddPart.aspx file for creating a form to add a new part into the database.

```
<table>
<tr>
  <td style="WIDTH: 119px; HEIGHT: 24px" align="left">Part No :</td>
  <td style="WIDTH: 52px; HEIGHT: 24px" vAlign="top">
    <asp:textbox id="txtNo" runat="server" CssClass="textbox"></asp:textbox></td>
</tr>
<tr>
  <td style="WIDTH: 119px; HEIGHT: 24px" align="left">Model :</td>
  <td style="WIDTH: 52px; HEIGHT: 24px">
    <asp:textbox id="txtModel" runat="server"
      CssClass="textbox"></asp:textbox></td>
</tr>
<tr>
  <td style="WIDTH: 119px; HEIGHT: 30px">Category :</td>
  <td style="WIDTH: 99px; HEIGHT: 30px">
    <asp:DropDownList id="DDCategory" runat="server"
      DataValueField="Category_No" DataTextField="Category_Desc"
      Width="120px"></asp:DropDownList></td>
```

```
</tr>
<tr>
  <td style="WIDTH: 119px; HEIGHT: 30px">Quantity :</td>
  <td style="WIDTH: 52px; HEIGHT: 30px">
    <asp:textbox id="txtQuantity" runat="server"
      CssClass="TextBox"></asp:textbox></td>
</tr>
<tr>
  <td style="WIDTH: 119px; HEIGHT: 28px">Description :</td>
  <td style="WIDTH: 52px; HEIGHT: 28px">
    <asp:textbox id="txtDescrip" runat="server" CssClass="Textbox"
      TextMode="MultiLine" Rows="5"></asp:textbox></td>
</tr>
</table>
```

Figure 6.5: HTMLTable Tag

Besides producing and displaying tables and graphics, ASP.NET offers another set of controls for the use of web form programmer, which is the web server controls / web controls. Throughout the development of FSS, web controls that come with the ASP.NET are used in preference most of the time as compared to HTML controls. Web controls are reusable component that can perform the same work as traditional HTML controls, but have the additional benefit of being programmable objects. In other words, they can be programmatically accessed, just like any other .NET object or class, respond to events, get/set properties, and do all the other things objects do. Figure below shows an example of ASP.NET web control – Dropdownlist.

```
<asp:dropdownlist id="DDCus" runat="server" DataValueField="Cus_ID"
    DataTextField="Cus_ID" Width="120px"></asp:dropdownlist>
```

Figure 6.6: Web Control (Dropdownlist)

6.2.3.2Processing Form Using Code Behind

After designing and creating form using .aspx file, the next step is to program the code behind page. Code behind is the page that handles and executes all the events triggered by the web server controls such as button, datagrid, dropdownlist and etc. Scripting delimiters <%.....%> have to be inserted into HTML page for the server-side execution. The .aspx web form and the .aspx.vb code-behind page is link by using a single line of code as shown in below:

```
<%@ Page Language="vb" AutoEventWireup="false"
Codebehind="AddPart.aspx.vb" Inherits="FieldServiceSystem.AddPart" %>
```

Figure 6.7: Codes That Link the .aspx Web Form and .aspx.vb Code Behind Page

Figure 6.8 shows the partial code extracted from DisplayCus.aspx.vb, a code behind page for DisplayCus.aspx. It shows how the event handler code was written for the datagrid web control.

```
Private Sub dgProduct_SelectedIndexChanged(ByVal sender As
        System.Object, ByVal e As System.EventArgs) Handles
        dgProduct.SelectedIndexChanged

    dgProduct.SelectedItem.Attributes.Item("onmouseover") =
        "this.style.cursor='hand'"

    dgProduct.SelectedItem.Attributes.Remove("onmouseout")
        btnUpdate2.Enabled = True
        btnDelete.Enabled = True
End Sub
```

Figure 6.8: Event Handler Code for Datagrid in Code Behind Page

6.2.4 Scripting Language

As described previously, ASP.NET is able to deliver client/server side scripting. It supports client side scripting such as Javascript that is executed at client's web browser. For FSS, Javascript has been used to handle some minor functions in order to reduce overhead at the server.

An example of the function is to generate a new password for each new user .Figure below illustrates a simple JavaScript function.

```
<script language="JavaScript" type="text/JavaScript">
<!-- // Add as many characters to theCharacters
var theCharacters="abcdefghijklmnopqrstuvwxyz0123456789"
// Set this to equal the amount of characters you want in your
password
var thePasswordLength=6

function generatePassword() {

  var password = ""
  var i = 0
  var randomString = 0
    while( i < thePasswordLength ) {
        i ++
        randomString =
          Math.floor(theCharacters.length*Math.random());
        password +=
          theCharacters.substring(randomString,randomString + 1)
    }

// Display the password inside the text box
Form1.passwordTextBox.value = password

        }
        // End -->
        </script>
```

Figure 6.9: JavaScript Function used to Generate Password

6.2.5 Cascading Style Sheet (CSS)

Cascading Style Sheet is used to gain better control of the interface design. CSS apply uniform styling to similar elements wherever they appear in the application. For example, by specifying the style of a textbox, all the texboxes in web forms with their property set to this CssClass will have the uniform appearance. Figure below shows partial CSS used to control the appearance of some items in the web form.

```
.TextBox
{
      border-right: #c7ccdc 1px solid;
      border-top: #c7ccdc 1px solid;
      border-left: #c7ccdc 1px solid;
      border-bottom: #c7ccdc 1px solid;
      font-size:8pt;
      font-family: Tahoma, Verdana, 'Times New Roman';
}

.Button
{
      background-color: gainsboro;
      border-right: darkgrey 1px solid;
      border-top: darkgrey 1px solid;
      border-left: darkgrey 1px solid;
      border-bottom: darkgrey 1px solid;
      font-size:8pt;
}     font-family: Tahoma, Verdana, 'Times New Roman';

.SubHeader
{
      border-top: 3px groove;
      font-weight: bold;
      font-size: 10pt;
      color: #330066;
      font-family: Tahoma, Verdana, Times New Roman;
}     text-align: right;
```

Figure 6.10: **Cascading Style Sheet**

In order to apply the styles which are specified in CSS to items on a page, the <link> element can be used. The following line can be inserted inside the 'Header' of any of the .aspx file.

```
<HTML>
   <HEAD>
   <title>report</title>
   <LINK href=" ../Style/iestyle.css " type="text/css" rel="stylesheet">
              :
              :
   </HEAD>
   <BODY>
   </BODY>
</HTML>
```

Figure 6.11: Line of Code That Links the .aspx Web Form and CSS File

6.2.6 User Controls

User controls are web forms encapsulated into reusable control. They are used to hold repetitive blocks of code that many of the pages in a web site need. A user control is saved with an .ascx file extension, and can be called from any of the ASP.NET pages in the application. User controls are used in FSS to create the header bar and menu bar for all the main pages of each module. Figure below shows the codes that should be inserted in the .aspx file in order to use the user controls.

```
<%@ Register TagPrefix="ucl" TagName="Sales_MarketingMenu"
    Src="../Controls/Sales_MarketingMenu.ascx" %>
<%@ Register TagPrefix="ucl" TagName="FssHeader"
    Src="../Controls/FssHeader.ascx" %>

<HTML>
   <HEAD>
      :
   </HEAD>
   <BODY>
         :
```

```
    <table>
      <tr>
        <td>
          <P align="left"><uc1:fssheader id="FssHeader1"
             runat="server"
             ImageUrl="../Image/SaleHeader.jpg"></uc1:fssheader></P>
        </td>
      </tr>
      <tr>
        <td>
          <uc1:Sales_MarketingMenu id="Sales_MarketingMenu1"
               runat="server"></uc1:Sales_MarketingMenu>
        </td>
      </tr>
    </table>
        :
  </BODY>
</HTML>
```

Figure 6.12: User Controls

6.2.7 Debugging

Debugging is an activity of finding and fixing the bugs in the system. If a program does not have any error, it does not mean that it is free of bugs. Through debugging, a programmer is able to trace the error and at the same time, correct or fix the error.

There are various types of errors that exist in the system. This includes compilation error, run-time error and logic error. Luckily, Microsoft Visual Studio.NET tool provides the features to identify the compilation errors and run-time errors. However, programmers need to identify and locate the logic errors by themselves.

The debugger used for the development of FSS is the Microsoft Debugger and with the help of the Internet Explorer browser. When and error occurs, the browser will display the error type and notifying which file and which line of the program that has the error. Figure below shows an example of an error message

prompted by the Microsoft Visual Studio.NET.

Sometimes, with this message, an experienced programmer will be able to notify and correct the corresponding error. However, a new programmer will need to debug the program line by line to detect the error. A breakpoint often used to trace the error found in the program.

CHAPTER 7

SYSTEM TESTING

7.1 Introduction

System testing refers to verification and validation of the program coded to solve the problem. Verification involves ensuring that the characteristics of a good design are incorporated into the program and the system is actually operates in the way it is expected to be. On the other hand, validation is used to test the execution of the program and to check whether system meets the requirements.

System testing plays an important role in the process of system development. It is a process of executing a program with an intention of finding bugs, errors or defects that present in the system. System testing also can be defined as the process of analyzing software item to detect the difference between existing and requires conditions and to evaluate the features of the software items.

After the coding and implementation process is done, the testing phase will begin. In this stage, many types of testing are done to ensure the end product or the final system will perform as what it should be. Many types of testing have to be done before the system is released to the user to ensure that the system is developed according to its specification and every function implemented in a program works correctly.

Testing is not the first place where faultfinding occurs, but testing is focused on finding faults, and there are many ways to make the testing efforts more efficient and effective.

7.2 Testing Concepts

Based on the research by Alka Jarvis, four basic concepts related to software testing are:

a) **Error Detection**

- Involves inspections and walkthroughs to detect error.
- At the unit level, test strategies based on functional testing
- At the system level, involves functional testing or behavioral testing.

b) **Error Removal**

- Involves debugging and strategies for identifying where the error occurs in the code and removes it.
- Strategies such as performing traces, setting traps, identifying "error state" and identifying the algorithm, function or module in which the error occurred

c) **Error Tracking**

- To find and correct the cause of error as it is to fix the error itself.

d) **Regression Testing**

- Testing to see if the fix or rework to the code actually fixes the error, fix it in one place and breaks it in another, or breaks the code in other places without actually fixing it at the point in the software where the fix was attempted.

7.3 Testing Objectives

The purpose of testing is to uncover the presence of errors or faults in software. It shows that a good test is one that has a high probability of finding an undiscovered error. A successful testing will result in quality software, of which with fewer errors and work according to specification and performance requirements. Testing can reveal different classes of errors with a minimum amount of time and effort.

Testing is a major quality control measure that is performed to ensure that the program executes correctly and confirm to the specified requirements. It provides a method for detection and removal of errors, as well as to test for system reliability.

7.3.1 Types of Faults

When no obvious fault exists, program is tested to isolate more faults by creating conditions where the code does not react as planned. Therefore, it is important to know kind of faults to seek. Fault can be categorized as follows:

a) **Algorithmic Faults**

Algorithmic faults occur when a component's algorithm or logic does not produce the proper output for a given input because something is wrong with the processing steps. These faults are easy to spot by reading through the program (call desk checking) or by submitting input data from each of the different classes of data that we expect the program to receive during its regular working. Typical algorithmic faults include :

I. Testing for the wrong condition

II. Forgetting to initialize variables or set loop invariants.

III. Forgetting to test for a particular condition (such as when division by zero might occur)

b) **Syntax Faults**

Syntax fault can be checked while parsing for algorithmic faults. This will ensure that the construct of programming language is used properly. Microsoft does not come with a compiler to catch syntax faults before web pages can only be traced after the web pages have been published.

c) **Documentation Faults**

When the documentation does not match what the application does, the application has a documentation faults. Usually, documentation is derived from system design and provides a clear description of what the program does, but the implementation of these functions is faulty and such faults can lead to other faults later.

7.4 Types of Testing

As described previously, the purpose of testing is to ensure the resulting component of program as well as the program as a whole fulfill the requirement specification and to eliminate faults in the program. Due to errors that had been done during the system development or system design, faults and failures may happen even when the entire system has been developed. Therefore, the main idea of testing is to demonstrate correctness of the program, identify the errors in the system coding or the system design. The faults that are discovered during the testing procedures will be corrected.

Testing involves the operation of the system under controlled conditions, both normal and abnormal and evaluating the results. Deliberate attempts are taken to make things go wrong for the system to determine whether things happen when they should not or things do not happen when they should be.

The testing process is carried out in stages to suit the system, as the system itself is composed of modules. As such, the development of FSS has gone through different stages of testing which consists of unit testing, integration testing and system testing.

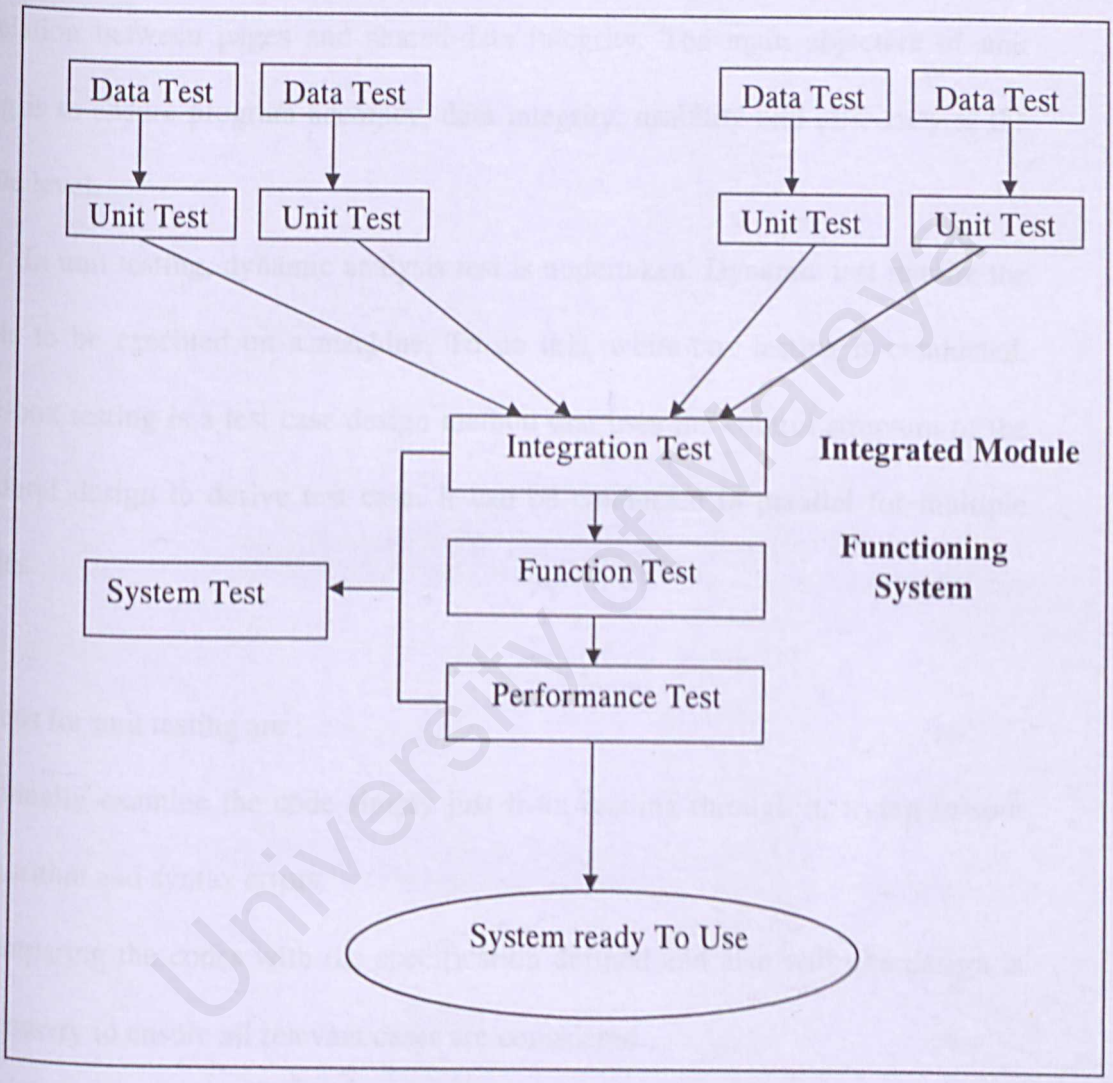


Figure 7.1: Flow Chart of Testing Stages

7.4.1 Unit Testing

Unit testing focuses on evaluating individual modules within a program. A module is tested independent of other modules. The sub function and input forms are verified and the flow from page to page is tested first. It is followed by the testing of the relation between pages and shared-data integrity. The main objective of unit testing is to ensure program accuracy, data integrity, usability and efficiency at the module level.

In unit testing, dynamic analysis test is undertaken. Dynamic test require the module to be executed on a machine. To do this, white-box testing is conducted. White-box testing is a test case design method that uses the control structure of the procedural design to derive test case. It can be conducted in parallel for multiple modules.

The steps for unit testing are :

a) Manually examine the code simply just from reading through it, trying to spot algorithm and syntax errors.

b) Comparing the codes with the specification defined and also with the design is necessary to ensure all relevant cases are considered.

c) Compile the code and eliminate remaining syntax faults.

d) Develop test cases to show that the input is properly converted to the desired output.

Unit Test Case Example

Unit testing was carried out on each function once it was completed. If it was tested to be functioning correctly, development of the next function was carried out. Else debugging was carried out to identify the error before having it tested again. Figure 7.1 shows partial test cases for unit testing on the function of adding a new service order into the database. This function is found in Service Call Management module.

Table 7.1: Test Cases for Service Call Management Module

No	Test Procedure	Expected Output	Test Result Analysis
1	Key in UserID and password. Click the login button.	With valid ID and password, Service Call main page will be displayed.	The Service Call main page is successfully displayed.
2	Select product number from the dropdownlist. Fill in data in the 'problem' field. Click the submit button.	A new service order will be created. An auto-incremented service order number should be generated and displayed.	New service order is created successfully and an auto-incremented service order number is displayed.

Description: Customer (preventive maintenance or warranty service) who have login successfully can access to Service Call Management module. Other users (FSS

administrator, staff from Sales and Marketing, technical manager and technician) will not have the right to access this module. Only customers with warranty service can request for service. In order to place a service order, customers have to select a particular product from the list and fill in the related problems. An auto-incremented service order number will be showed when customers click on the submit button.

7.4.2 Integration Testing

The integration process is carried out after the unit testing has been done. When satisfied that individual components or modules are working correctly and meet the system objective during the unit testing, these modules are then combined into a working system. Several independent modules combined into a single system cause some unpredicted and unexpected errors that are related to the integration of these modules. Therefore, integration testing is a systematic approach for constructing the application while tests to uncover errors associated with interfacing of different components or modules.

One of the objectives of conducting integration testing is to determine whether the group of program's interface is detective or not. For example, links button in the main page of each module is tested whether it links to its own sub pages and other modules or not when all the modules have been integrated.

Another objective is to ensure that the different unit-tested modules in FSS can function smoothly together to the exaction of the system requirements. The major concerns here are the shared data, user privilege and security.

There are many approaches that can be used to do the integration testing,

such as Bottom-up integration, Top-down integration, Big-bang integration and Sandwich integration. For this system, Bottom-up approach has been used. When this method is used, each component or module at the lowest level of the system hierarchy is tested individually first. Then, the next components to be tested are those that call the previously tested ones. This approach is followed repeatedly until all the components or modules are included in the testing.

After finishing the integration testing, those errors and faults discovered were corrected as soon as possible in order to proceed to the system testing phase.

7.4.3 System Testing

After all the modules are completed, the entire system must now be validated. This validation is done by carrying out the system testing process. Testing the whole system is very different from unit and integration testing. When undergoing the system testing process, the major difference is that one needs to work with the entire environment of the system such as hardware, software, databases and computer systems.

The objective of system testing is to verify and validate the functional and nonfunctional requirements of the system. The functional and nonfunctional requirements of FSS are as defined in Chapter 4.

There are several types of system testing that can be used to test a software system. However, only three types of system testing are used for this system. The following section discusses some of the modules testing in detail.

a) **Function Testing**

Function testing focuses on the functionality of the system. It is based on the system functional requirement. The process is to check whether the system provides the function to do the task, which it supposes to do.

b) **Security Testing**

The main objective of security testing is to verify that protection mechanism built into the system will protect it from improper penetration. For example, security features had been added into the system whereby users are not be able to browse the page once they have logged out. This mechanism is tested during system testing. Besides that, the encryption and decryption functions which are used in the application to manipulate all the user passwords also tested thoroughly.

c) **Performance Testing**

This testing is carried out after the function testing process. When the system performs the function required by the requirements, the testing process then turn to test the way in which those functions are performed. Thus, the performance testing addresses the non-functional requirements. The purpose of this testing is to test the run-time performance of this software within the context of an integrated system. It involves both hardware and software instruments.

7.5 Data test

Test data was used in the execution of the program. For this system, a series of tests were conducted with data that are individually designed to represent the real environment as closely as possible. Three categories of data were used to execute the program and they are describe as follows :

a) **Normal Test Data**

Testing with normal test data is a procedure whereby the program goes through a light and simple test to determine whether the program runs or not to determine it is error-free.

b) **Extreme Test Data**

Testing with extreme test data is a procedure whereby the program goes through an intensive test. This test is necessary in order to determine the system's capacity and how well the system can handle huge amounts of data without affecting its accuracy and efficiency in performance.

c) **Erroneous Test Data**

Testing with erroneous test data is a procedure whereby the program goes through an erroneous test. Erroneous test is a test where errors are keyed in intentionally. This test is vital to determine how the program or system can handle such errors or incorrect data and from there, the reliability and the efficiency of the system can be predicted.

CHAPTER 8

SYSTEM EVALUATION

8.1 Introduction

When the system is fully tested for any errors and all of the objectives have been achieved, system evaluation is the next task to be performed. During the period of coding and implementation, various problems were encountered. Therefore, this chapter will highlight some of the problems faced throughout the project development and also the solutions that have been taken to solve those problems. Besides that, this chapter will also include the evaluation of the system to identify its strengths and limitations. As suggestion for further improvement of this system, the possibility to enhance the system also explored.

8.2 Problems Encountered and Solution

From the beginning of the project towards the end of the system development process, many problems were faced. Among the encountered problems, some can be solved by using certain solutions while some remain unsolved or could not be solved due to a few factors such as hardware limitations, lack of resources and etc. The following are some of the problems that arise during the development process.

a) **Difficulty in Determining the Scope of the System**

During the initial state of the system development, determining the scope of the system is the most critical and difficult task as the author was not familiar with the concept of field service. As this involves developing a filed service system, to build a full-fledged system is merely impossible within the given time frame. Inexperience with the current technologies is another hindrance

to implement true workable field service system. Basic knowledge is needed as a foundation in building an application of this nature.

Solution:

A number of discussions were held with team member to outline the scope of the project during the initial stage of the project. Besides that, the author also seek advises from the thesis adviser, Mr. Basri in order to define the system requirements. Reviews also have been done on the various field service systems that are available on the Internet to gain a better understanding of the concept of field service.

b) **Difficulty in Determining / Choosing Development Tools**

Choosing suitable development tools is the most important and critical process in the software development cycle. There are many software tools available in the market today. For example: ASP.NET, Java, Visual Basic, VB.NET and etc. Further more, there are also many choices for other software such as database. Unfortunately, this wide range of tools available had raised the problems on making the decision in choosing the most suitable tools for the system needs.

Solution:

In order to make sure that the suitable tools are chosen for this system, the needs of the system are defined. Then, research on the development tools is carried out. This process is accomplished by surfing the Internet and seeking advice from people who are familiar with those tools.

c) **Lack of Knowledge and Experience in Web Based Programming**

Lack of knowledge and experience has proved to be an obstacle at the beginning of system development. This is because the concepts of web programming and application are quite hard to understand, as it is different from the conventional programming concepts. The exposure of the new technologies such as Visual Studio.Net and Microsoft SQL Server 2000 as well as new programming languages like ASP.NET and ADO.NET has increased the learning curve before the author start to develop the system.

Solution:

Surfing the Internet for information and advance learning on the concept of client-server and net programming which included the operation of web server, were some of the approaches to overcome this problem. In order to solve those ambiguities, the author had referred to various materials that are relevant, besides seeking advice and guidance from course mates and experienced seniors.

d) **Problems Related to Mail Server**

Due to the limited access to the faculty mail server, we are unable to send mail through the mail server at fsktm.um.edu.my, neither do we have access to the University Malaya mail server. This is one of the major problems faced during system development, as emailing is one of the system requirements that need to be implemented.

Solution :

For a trial run of the system, we resort to the perdana mail smtp server at 202.185.111.135 which we can only send mail to the perdana mail account holder.

e) **Problems Related to Layout Design**

ASP.NET is still a new programming language to the team in the initial phase of development. We were facing dilemma to use a frame or to include side bar from a different page. Frame will enable the side bar to have its own events but affects the interface design. On the other hand, by including another page as a side bar, we can't have its own events because it causes error when to run at server form present in a page.

Solution:

After some research, we discover that by using user control, we can easily solve the problem. User control can be included in every page and at the same time have its own events. Thus, we can have the side bar with search function, to pass session values as well as provide links to other pages.

f) **Difficulty in Understanding the Programming Errors**

The error message generated by Microsoft Debugger provided by Visual Studio.NET usually comprised of error code and error message, which are sometimes vague and unclear of the cause. Understanding the error messages was a constant struggle because the author needs to repeat the debugging,

correcting and testing process until the program was free of bugs. This may due to the lack of experience in ASP.NET programming.

Solution:

In order to overcome this problem, discussion with team member and other course mates who also use the same technology was a great help. Besides that, many of the errors correction were done through trial and error approach.

8.3 Evaluation by End User

Due to the time constraint, a proper or formal end user assessment cannot be conducted. Therefore, an informal approach was taken to let the end user to evaluate the system. The system was review among the author's course mates to obtain feedback regarding the system. Feedbacks received from the users are examined and modifications of the system are carried out in order to improve or enhance the functionality of the system.

8.4 System Strengths

Feedbacks from users and testing results have revealed several key strengths of FSS. The list below will explain and discuss the strengths in details :

a) **Simple and User Friendly Interface**

The interface of the system is simple and easy to use. The page is designed to suit a wide spectrum of user. Thus, the learning curve is foreseen to be short and a user should be able to use the system with ease within minutes. Some

useful web controls such as datagrid, checkbox and etc are used to make the interface simple and organized. Clear, precise instructions and guidance are also provided to guide the user. Most of the time users only need to select from the listed options, without the need to input value. These features make the user task much easier and at the same time, minimize the likelihood of typing error. Even if mistake is made, users can still easily aware of the mistake through the message prompted by the system. Hence, user will find FSS easy to use and master.

b) **Different User Privilege**

This system can be accessed by five different types of users. They are customer, system administrator, staff from Sales and Marketing, technical manager and technician. Different level of users will get different view of the system and users only can access to the page that they have authorized to.

c) **Security Features**

This system includes the security control which only allows the authorized user access to the system. Since FSS is a password-protected site, each user has a unique user ID and password. Hence, unauthorized users are prohibited from accessing the system. Moreover, all the users' passwords are encrypted before they are store into the database. Thus, it increased the system security. Besides that, users are not able to browse the page once they have been logged out from the system. This can prevent other user from modifying any

of the details found in the page.

d) **Reliable System with Effective Error Handling**

To avoid the run-time error, the FSS is developed with error handling function, by which it is able to cater most of the possible errors encountered. Error message will be displayed when exceptions encountered. For example, if user clicks on the Go button without input any keyword in the search field, a message box will be prompted asking the user to input keyword(s) for search.

e) **System Transparency**

System transparency refers to the condition where the users do not need to know where the database resides, how the system is structured, its database management system and the underlying system architecture. User only interacts with the upper layer of the system.

f) **Availability and Easy Accessibility**

The FSS is a web-based application and it can be accessed easily. This system is accessible as long as the intended users have access to the Internet.

g) **Reasonable Response Time**

Each page is designed to be lightweight. These pages are loaded in a reasonable amount of time to ensure that the users and clients need not wait

too long to view the page they required. This is accomplished by avoiding the use of heavy graphic.

h) Web Enabled

The system was based on the web technology. It was using the client server approach that allowed processing load to be shared between the client and the server, thus reducing the burden on the server and allow it to provide better service

8.5 System Constraints/Limitations

As in other system, FSS has some limitations and weaknesses which are unavoidable, although every bit of effort and time has been used to ensure that the best system is developed. This may due to time constraint and other factors such as lack of programming skills and experience. However, these limitations have in no way stopped FSS from achieving its objectives. These limitations should be addressed in future development and enhancements.

The following points illustrate the constraints of FSS :

a) Limited Capabilities of Search Function

The search functions provided in User Management and Sales Management modules are not flexible enough in assisting the user on finding a particular record. Those functions provide limited filtering capabilities with only basic filtering criteria. For example, the search function in the User Management module only allows user to search the record by using either employee ID or

name.

b) **No Reports are Generated for Management**

For Sales and Management Module, report generation is not provided. As a result, personnel from Sales and Marketing is not able to view report regarding the total number of customers based on their type, list of products purchased by a particular customer and etc. In other words, there is no summary information which can be used by Sales and Marketing to improve management function.

c) **Technician are Not Able to Request for Parts**

Currently, if a particular part is out of stock, technicians are unable to request for it by using the FSS although they need it in their repair work. FSS only allows technicians view all the parts details. This may lead to inconveniences as technicians have to check the part's availability from time to time, as there is no way for them to know when the parts will be replenished.

d) **Online help Module is Not Provided**

Online help module is definitely the most desirable and effective feature. However, it is not implemented in this system due to the time constraint.

e) **Lack of Backup Feature**

FSS does not provide any backup capabilities and this presents a problem to

the database where there will be no way to securely store important records in case of any disaster. Although SQL Server 2000 does provide backup capabilities, it would be too difficult and complicated for the end user to understand the steps involved in backup a database.

8.6 Future Enhancement

As discussed previously, the FSS has some limitations and weaknesses that need to be addressed in future enhancement. Listed below are some of the approaches that can be taken to enhance the system :

a) Enhance the Search Function

The functionality of the search function in User Management and Sales Management modules should be enhanced to include more powerful features. For example, additional search options can be provided so that user will have more alternatives in the searching process.

b) Report Generation for Sales Management Module

Report generation should be added into the Sales Management module. The system should be able to generate various reports such as report on total amount of product sold within a month, number of customer categorized by type and etc. This will help the Sales and Marketing's staff in monitoring and coordinating the management activities.

c) Allows Request for Parts

Parts Management in Sales Management module should be enhanced to include functionality whereby a technician can request for parts. System should be able to 'answer' the request from technician by notifying the technician when a particular part is available. This can be accomplished by including the email alert function in the Part Management module.

d) Provide help Facility

Help file can be provided for the user in order to guide them in using this system. The user can browse to the help module and search for the topic they needed in order to get the help information. This is very important especially for novice users who just start using the system

e) Database Housekeeping and Backup Application

FSS needs a backup and house keeping application to ensure that its database is back up constantly to avoid any loss of data. The house keeping feature will delete absolute records and reclaim the empty space in the database for new records, making the database more efficient and well kept.

8.7 Knowledge and Experience Gained

Knowledge gained throughout the development of FSS is undoubtedly valuable. The knowledge and experiences gained will sure be proven useful in the future.

a) Setting and Configuration

During the development process of the system, the author has the opportunities to set up and configure the development tools. For instance, the author had learnt how to install and configure SQL Server 2000. Since the system is a web-based application, the author also learnt how to set up a web server using the IIS. During the setup and installation process, some problems occurred and the author has gained valuable experience in solving those problems.

b) Learnt Additional Software Tools

After finished developing the system, the author has learnt more programming languages such as VB.NET, ASP.NET and etc. Although those languages are not fully mastered by the author, this is a great experience to learn those languages.

c) Improve Project and Time Management

The author has learnt how to manage a project so that it can meet the deadline without sacrificing the application functionality and quality. Time planning is important especially in allocating time for a project. As the time given for developing a system is quite short, the author and team member must plan the schedule properly so that it will be finished on time. A good touch of concentration would be definitely being useful.

8.8 Conclusion

As conclusion, the FSS has achieved its objectives as a value added web-based field service system. FSS supports various types of users by providing specific functionalities for different level of users. Through the use of this system, field service operations can be carried out more effectively and efficiently.

During the initial stage of the system development, a lot of work has been put into the research of what functions that the FSS should have in order to fulfill the basic requirements of a field service system for any field service organization. More effort is even put in to make sure that the final system would be a reliable and efficient system. In order to achieve this, testing has been conducted rigorously to ensure that the system is bugs free.

Throughout the development of the FSS, a lot of knowledge has been gained. This include working with the processes of software development methodology, designing the system using structured approach, working with various types of development tools and programming with Visual Studia.NET.

As the final word, the Field Service System (FSS) project is a very interesting a beneficial project to work on.

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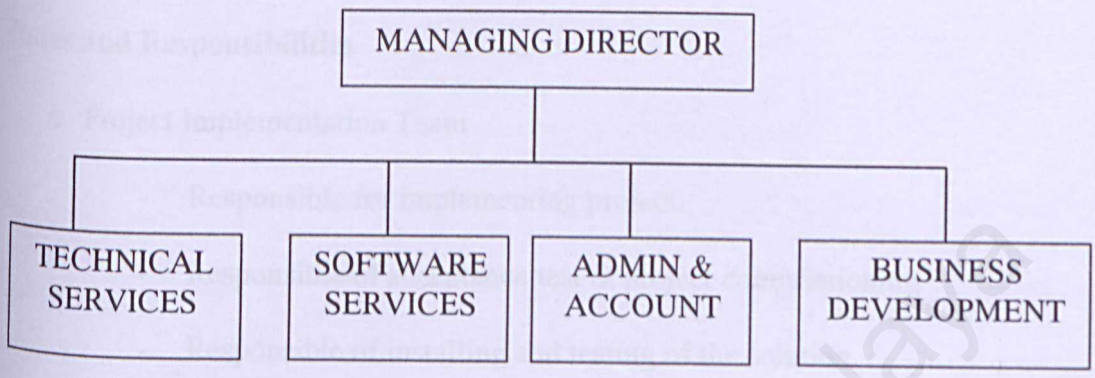
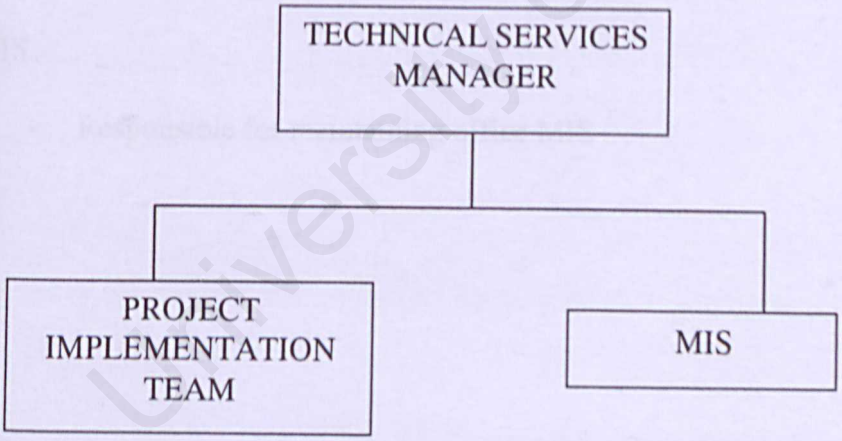
Appendix A: Business Information Technology Organization Chart

Organization Structure – Management



Organization Structure – Technical Services



Main Functions:

- To implement project initiated by Business Development Division in timely manner and quality services.
- To provide a comprehensive support structure to the customers.

- To provide in-house facilities to support company operations
- To assist Business Development Division in related to pre & post sales function

Roles and Responsibilities

- Project Implementation Team
  - Responsible for implementing project.
  - Responsible of acceptance test & project commissioning
  - Responsible of installing and testing of the solution
  - Responsible for support and maintenance services
  - Responsible for pre-sales and post-sales support which include benchmarking system.
- MIS
  - Responsible for maintaining office MIS

Appendix B: Interview

Date: 26 June 2003

Venue: Business Information Technology (M) Sdn.bhd

Interviewers: Chuah Hui Koon and Khoo Chai Ee

Interviewee: Mr Basri Mohd Ghazi (Technical Manager)

Question 1: Is there any Field Service Management/IT support service system being used in your company currently?

Answer:

The company is currently using a simple computerized field service system to keep track of the customer service request. Customers' service requests are received through phone calls. BIT only provide after sale service to the customer who purchase products from the company.

Question 2: What is the functionality of the current field service system?

Answer:

The current Field Service system has been used for 6 months. The basic functionality of the current system is to record the service request information from the customers and the services' solutions by the technicians or engineers.

Question 3: Can you please describe the procedure involved for a field service/IT support request which is reported? (From customer call until service is provided)

Answer:

BIT does not have single point of contact/help desk to answer the service request from customers through phone calls. Any BIT's engineer or technician who is around the office will answer the call. The engineer or technician who received the call will try to solve the customer's problem over the phone. The service request information will be entered into the Field Service System. If the problem cannot be solved, a work order is created and appointment will be scheduled. The technical manager will assign the work order to technician who is around the office. The technician will have to update the customer about the service request status through phone. Before a technician go for site service, he will have to gather information about the customer by checking through piles of paper-based service contract. Besides that, the technician will have to call back to the office to check for the availability of parts or components. The technician will enter the service's solutions into the current system when they are back at the office. The technicians are allowed to claim for allowances by filling in the form.

Question 4: How does the technician report the closed work order/service request to the technical manager?

Answer:

The technician will submit weekly report to the technical manager. The report includes time taken to solve a problem, replaced parts and resolutions to solve the problem. Factors that should be considered for the technician's scheduling are: service importance, availability, skill, experience and workload. The technical

manager will assign pending/new work order to technician who is around the office, or the technical manager will inform the technician by phone calls.

Question 5: Is there any computerized Inventory Management System being used in your company currently? Does it merge/interact with other system (Field Service System)?

Answer:

BIT keeps some parts or components in order to fulfill customer request as in the service contract. All the inventory details are recorded by using Microsoft Excel currently. The technician will need to refer to this file to check for parts availability. The sales and marketing department is responsible for the inventory management. Besides that, the sales and marketing department is also responsible for the customer contract management. There are two types of contract: maintenance contract and warranty service. Both contracts are paper-based.

Question 6: What are the restrictions or constraints regarding the current field service system? (If there's any)

Answer:

The restrictions of the current system are it only provides basic function and it does not integrate with the other system in the company such as the inventory management system.

Question 7: Does the technical department plan to enhance the existing Field Service System? If yes, what are the expected features and functionality that should be added?

Answer:

The technical department plan to enhance the current existing Field Service System as this system will become part of the company management system. The technical manager expect features and functionality to be added into the system which include parts inventory, technician availability, movement, skill level etc, preventive maintenance schedule (reminder for due maintenance), customer equipment lists and maintenance records, web support page for customers (allow customers to report problem online and check repair status) and report generator.

Appendix C: The Service Process

COMPANY OBJECTIVES AND STRATEGY		
FINANCIAL	**MARKET PRESENCE**	**RESOURCES/SKILLS**
Revenue/cash Margin/return on assets Asset turn	Share Product strength, image User satisfaction/loyalty	Production/technology Marketing/service/finance

INTERNAL AND EXTERNAL ENVIRONMENT			
RESOURCES AND SKILLS	**GENERAL EXTERNAL**	**CUSTOMERS**	**COMPETITION**
Financial Production/technology Service skills Channel presence/loyalty	Technology Economy Legal Political	Needs Buying power Behaviour Use patterns	Numbers Resources Skills Behaviour

SERVICE OBJECTIVES AND STRATEGY			
MONETARY	**STANCE**	**CUSTOMERS**	**CHANNELS**
Revenue/cash Share Asset turn ROA/profit/margin	Aggressive/reactive Efficient Leader/follower Specialist	Number/type Loyalty Location Penetration	Own Third party Co-operation

SERVICE POLICIES - SERVICE MIX				
CUSTOMERS, MARKETS	**SERVICE PRODUCTS**	**PRICES**	**PROMOTION OF SERVICE PRODUCTS**	**DISTRIBUTION**
Number Value Spread Variety Penetration	Range Leadership Quality Number Contract terms	Margin Flexibility Negotiability Discounts Cross-subsidy	Target population Objectives Budget Means/media Message	Channel choice Parts vs labour Motivation Support Training

SERVICE POLICIES - SERVICE IMPLEMENTATION AND SUPPORT					
ANALYSIS, ASSESSMENT	**DECISION MAKING**	**PLANNING**	**ORGANISATION INCENTIVES**	**TARGETS, PRODUCTIVITY**	**CONTROL**
Obtain/analyse internal and external data	Create choices	Review/audit	Structure to achieve all aspects of plan	Fix group & individual targets	Control performance achievement
Prepare data for use in decisions & planning	Evaluate choices	Co-ordinate decisions	Allocate responsibility	Provide incentives to achieve	Control expenditure
	Decide on service mix	Provide framework for targets and control	Fix budgets		

ACHIEVEMENT - PERFORMANCE		
REVENUE/PROFIT	**MARKET SHARE**	**CUSTOMER CARE**
Total & by area/product/client	Revenue & physical: by product, area, market, accounts, key accounts	Opinion of service and of company
Cash flow/asset turn	Number/type of clients	Level of service
Growth		
Return on assets/margin		

ACHIEVEMENT - PRODUCTIVITY		
FINANCIAL	**SEMI-FINANCIAL**	**PHYSICAL**
service cost as % of revenue	Revenue per unit input (engineer, parts, etc.)	Input-output ratios (units serviced per man)
Gross or net contribution of service spend (total & per item of service mix)	Machines serviced per amount spent on service etc	Inter-input ratios (managers per man)
		Inter-output ratios (mix of products serviced)

Adapted from Stone, M and Wild, A (1985). "Field Service Management", Pg 11.

Appendix D: User Manual

TABLE OF CONTENTS

1.0 Introduction

The purpose of doing this user manual is to provide some helpful guideline to the FSS users so that they can make the fully use of this system.

Field Service System is a web based system that focused on helping the field service organizations to effectively manage their customer service by facilitating the job scheduling among the field service workers, management of customer information and report generating.

Two team members jointly develop this project. This user manual focus on the features developed by the author. User manual for the other 2 modules, which are Dispatch management module and Work order management module can be found in the documentation of Ms Chuah Hui Koon (WEK010060).

This user manual is organized into 2 major sections. The first section specifies the installation and configuration process needed to run the application, while the second section contains instructions to get started to use the system. This user manual focuses mainly on :

a) Service call management module – for customer

b) User management module – for system administrator

c) Sales management module – for sales and marketing staff

Before starting the walkthrough, user will receive the user id and password from administrator by email.

2.0 Getting Started

2.1 Installing the database

1) Stop the SQL Server Service Manager
2) Copy and paste both the FSS2_log and FSS2_Data to C:\Program Files\Microsoft SQL Server\MSSQL\Data.
3) Start the SQL Server Service Manager
4) User Id=sa
5) Password=fieldservice

2.2 Installing the application

The process of installing the projects has two parts

2.2.1 Place the FieldServiceSystem folder

The first part is to place the folder containing the projects in the following location on your system:

C:\inetpub\wwwroot\FieldServiceSystem

2.2.2 Creating a Virtual Directory

1) Start IIS by opening the **Control Panel,** double clicking the **Administrative Tools** icon and double clicking the **Internet Services Manager** icon. This opens the Internet Services Manager dialog (Figure 2.1).

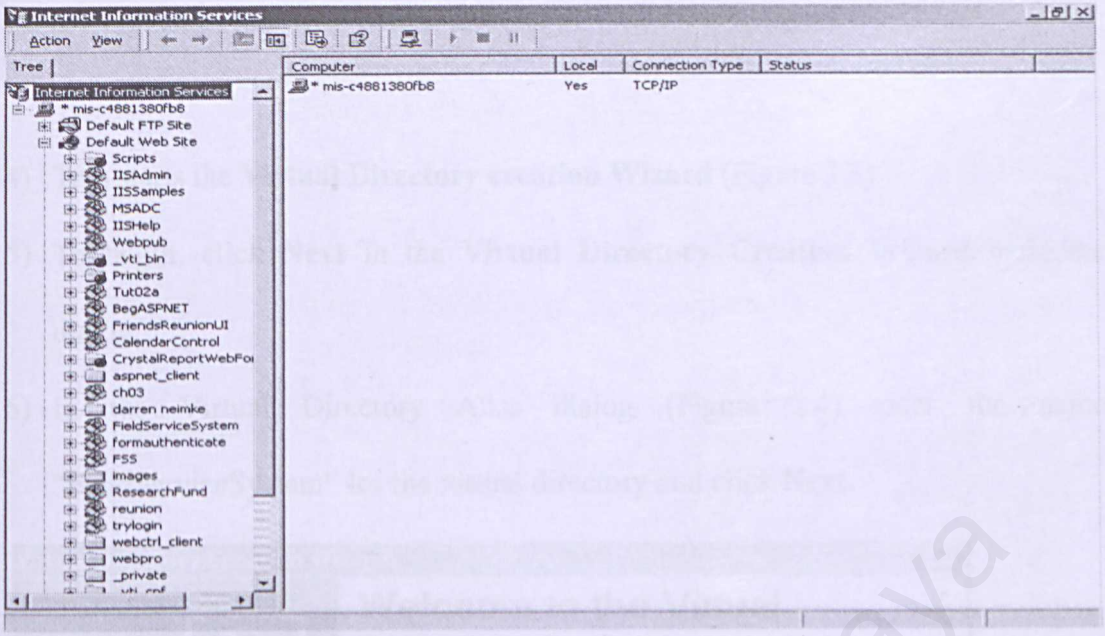


Figure 2.1: Internet services Manager dialog of Internet Information Services

2) In the Internet Services Manager dialog, expand the **Default Web Site** directory by clicking the + to the left of it. The **Default Web Site** subdirectories are virtual directories.

3) We can create our virtual directory, right click **Default Web Site**, select **New** and then **Virtual Directory** as shown in Figure 2.2.

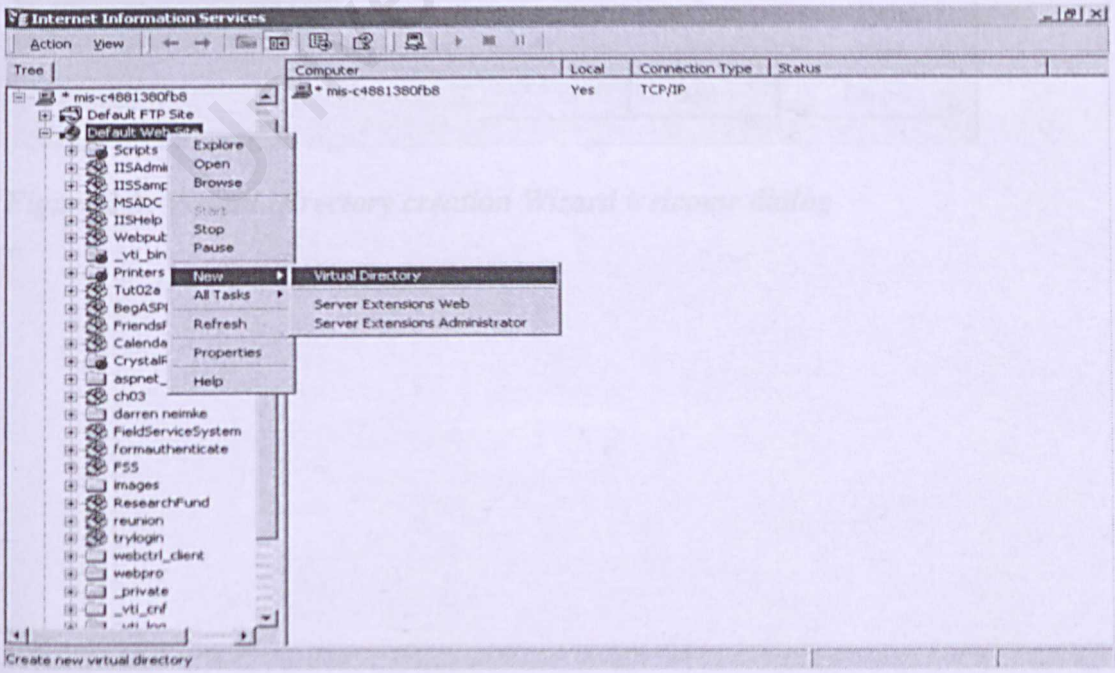


Figure 2.2: steps to create virtual directory

4) This starts the **Virtual Directory creation Wizard** (Figure 2.3).

5) To begin, click **Next** in the **Virtual Directory Creation Wizard** welcome dialog.

6) In the Virtual Directory Alias dialog (Figure 2.4) enter the name "FieldServiceSystem" for the virtual directory and click **Next.**

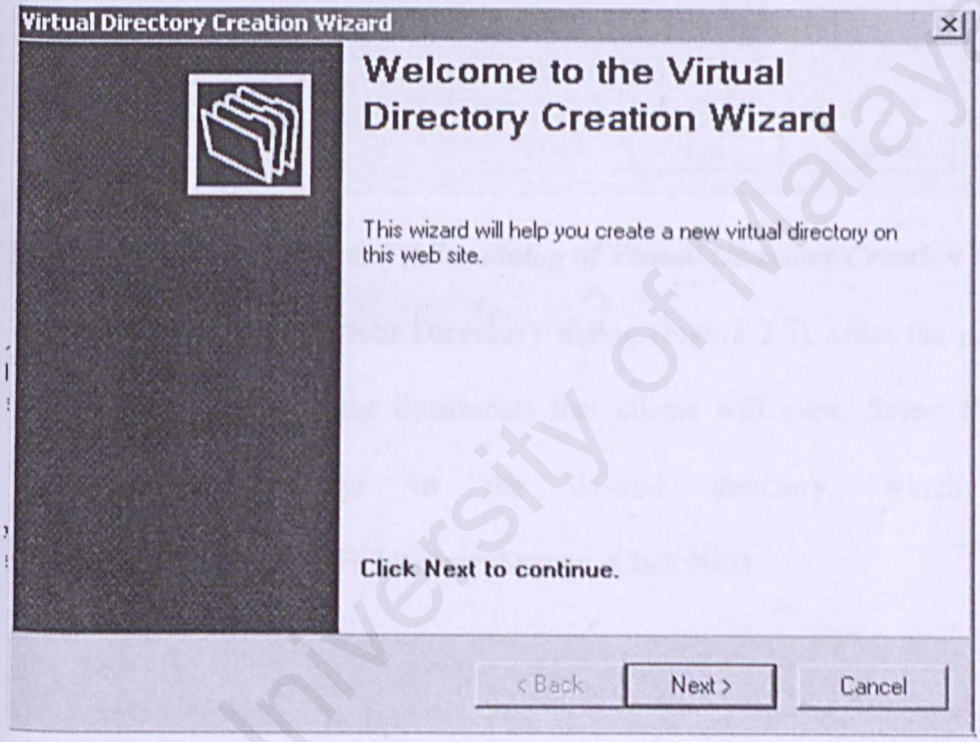


Figure 2.3: Virtual Directory creation Wizard welcome dialog

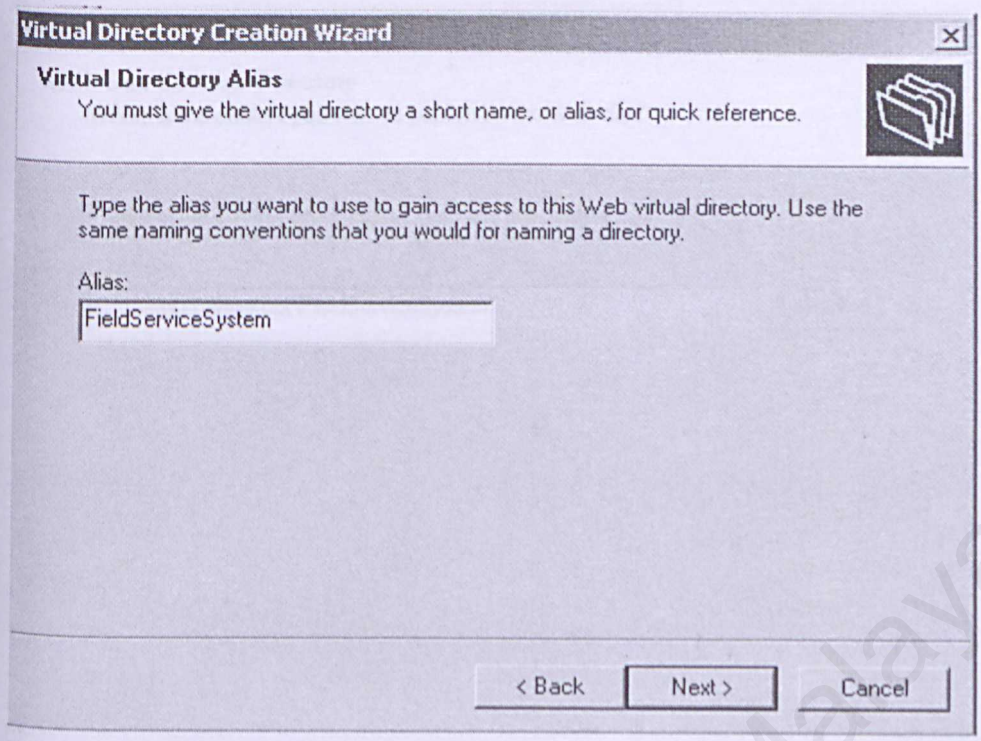


Figure 2.4: Virtual Directory Alias dialog of Virtual Directory Creation Wizard

7) In the **Web Site Content Directory** dialog (Figure 2.5), enter the path for the directory containing the documents that clients will view. Select the Browse button to navigate to the desired directory, which is the C:\Inetpub\wwwroot\FieldServiceSystem. Click **Next**.

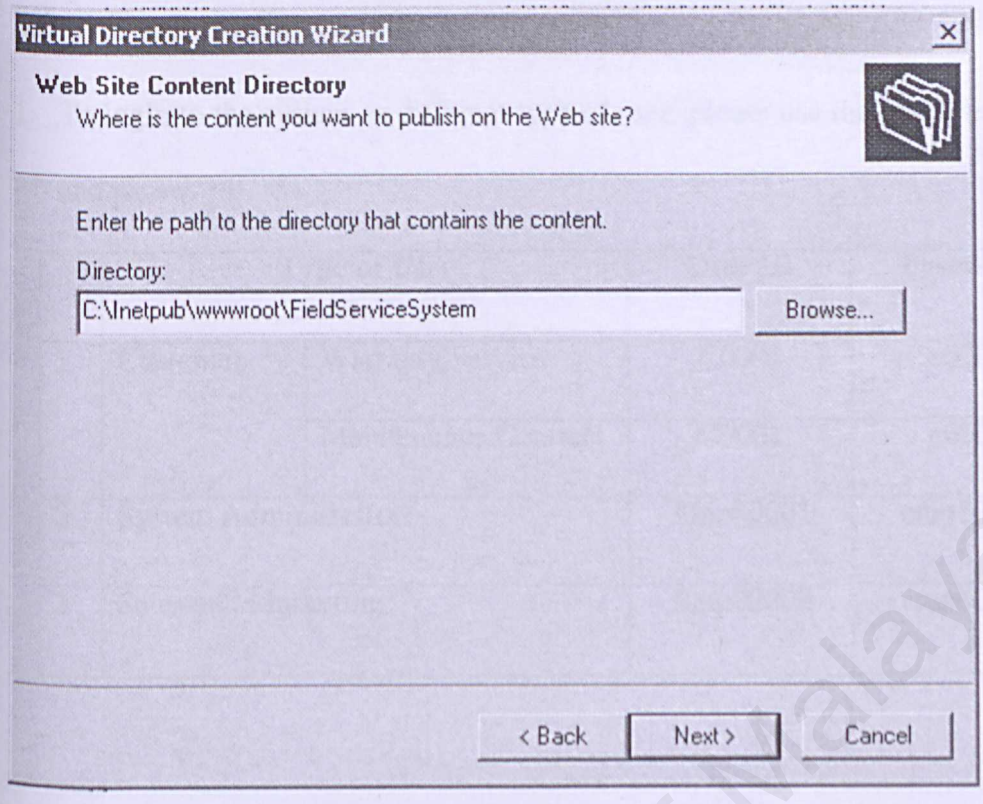


Figure 2.5: Web Site Content Directory dialog of Virtual Directory Creation Wizard

8) Click **Next** in the **Access Permissions dialog box**.

9) Click **Finish** to complete the creation of the virtual directory and exit the Virtual Directory Creation Wizard.

2.3 Running the application

1) Open the Internet Explorer

2) Enter the following address into the address bar: http://localhost/FieldServiceSystem/Secure/Login.aspx

3.0 Login to the system

1. To login to the system as different type of user, please use the following user ID and password:

	Type of User		User ID	Password
1	Customer	Warranty Service	C0005	c0005
		Maintenance Contract	C0001	c0001
2	System Administrator		Emp00001	emp00001
3	Sales and Marketing		Emp00008	emp00008

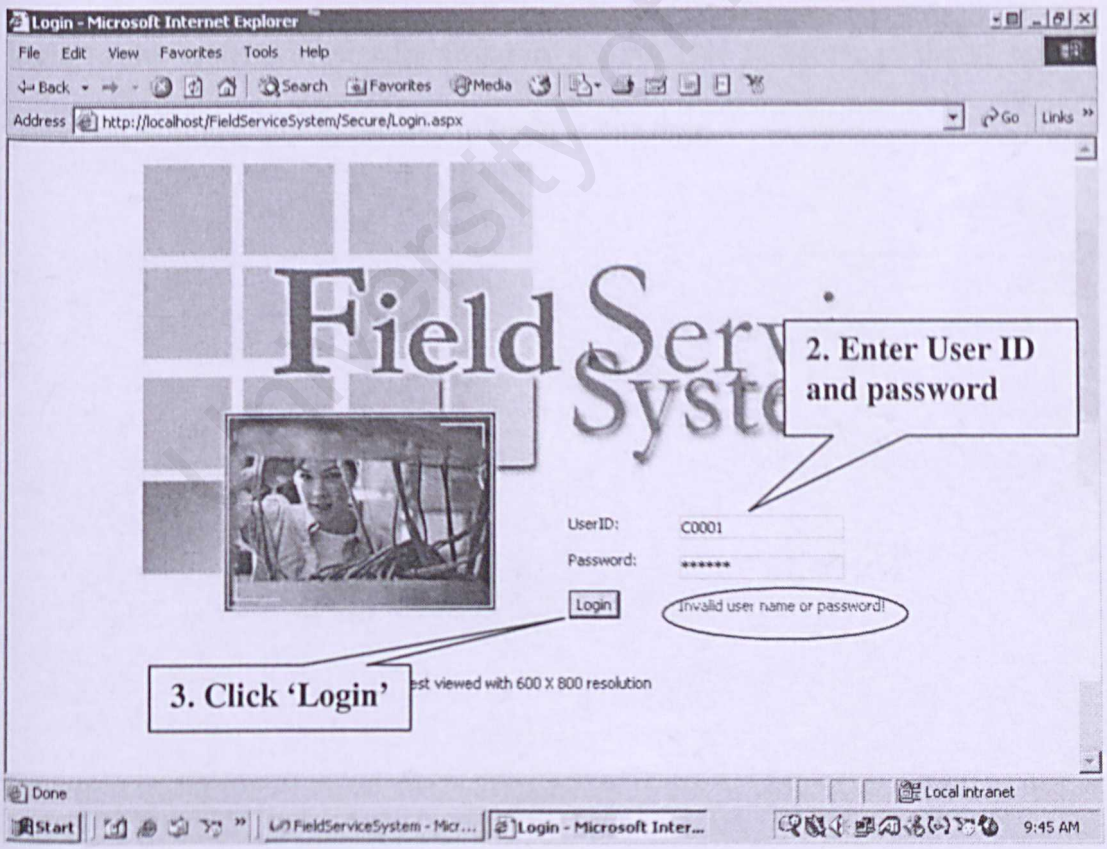


Figure 3.1: FSS Login Page

2. Enter User ID and password in the appropriate field, as shown in Figure 3.1.
3. Click 'Login'. If User ID or password is invalid, error message "Invalid user name or password" will be displayed. Otherwise, if login is successful, users will be directed to different module base on their type.

	Type of User	Module
1	Customer	Service Call Management
2	System Administrator	User Management
3	Sales and Marketing	Sales Management

4. For system administrator, if currently there is a system administrator who has login to the system, other administrators are not able to access to the system. Only one administrator is allowed to login at one time.

3.1 Service Call Management Module

If a user login as a customer, the user will be directed to the Service Call Management Module as shown in Figure 3.2. The header and a set of toolbar buttons will be displayed on the top of every page in this module. Every button of the menu will have its own page. Functions for each sub module will be explained in the following section. Customers can logout using the 'Logout' link in this module.

3.1.1 Service Request

If the 'Service Request' button is clicked, customer will be directed to the page as shown in Figure 3.2

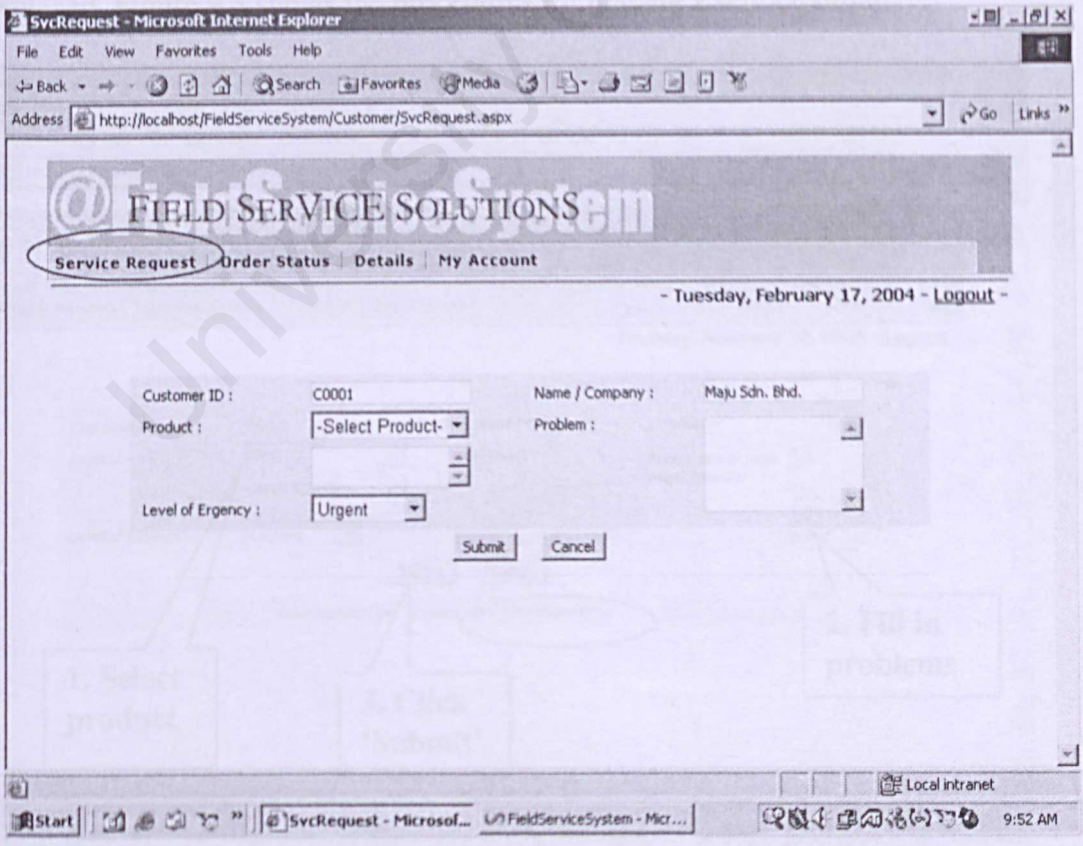


Figure 3.2: Main Page of Service Request

In the Service Request main page, different type of customer will have different type of privilege. For customers with warranty service, they are able to place a service order, check for the order status and view their own details. Customers with maintenance contract also can check for the order status and view their own details, but they are not allowed to place a service order.

3.1.1.1 Customer with Maintenance Contract

1. In order place a service order, select a product number from the dropdown list. Only product which is still under warranty will be displayed in the list.
2. Fill in the problem associated with the selected product.
3. Click the 'Submit' button. A new service order number will be generated and displayed. Figure 3.3 shows the procedures for placing a service order.

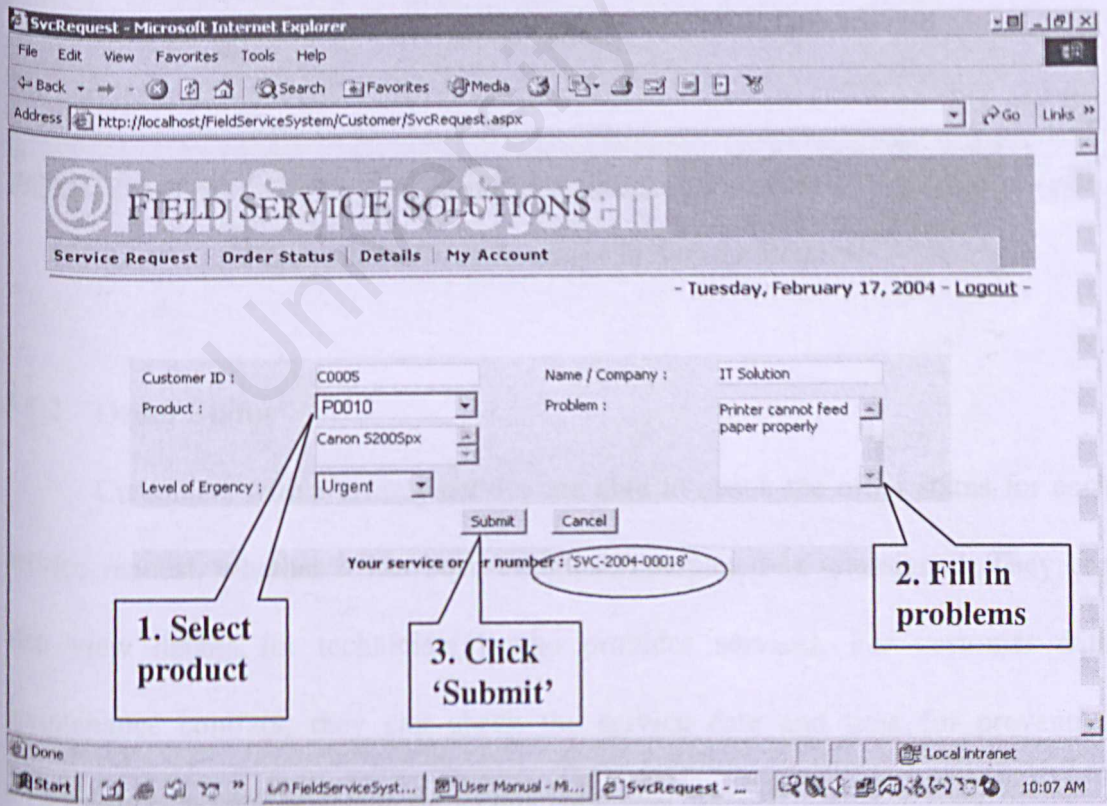


Figure 3.3.: Service Request

4. If customers do not select any product or fill in the problem, error message will be displayed on the top of the page when they click the 'Submit' button. (Figure3.4)

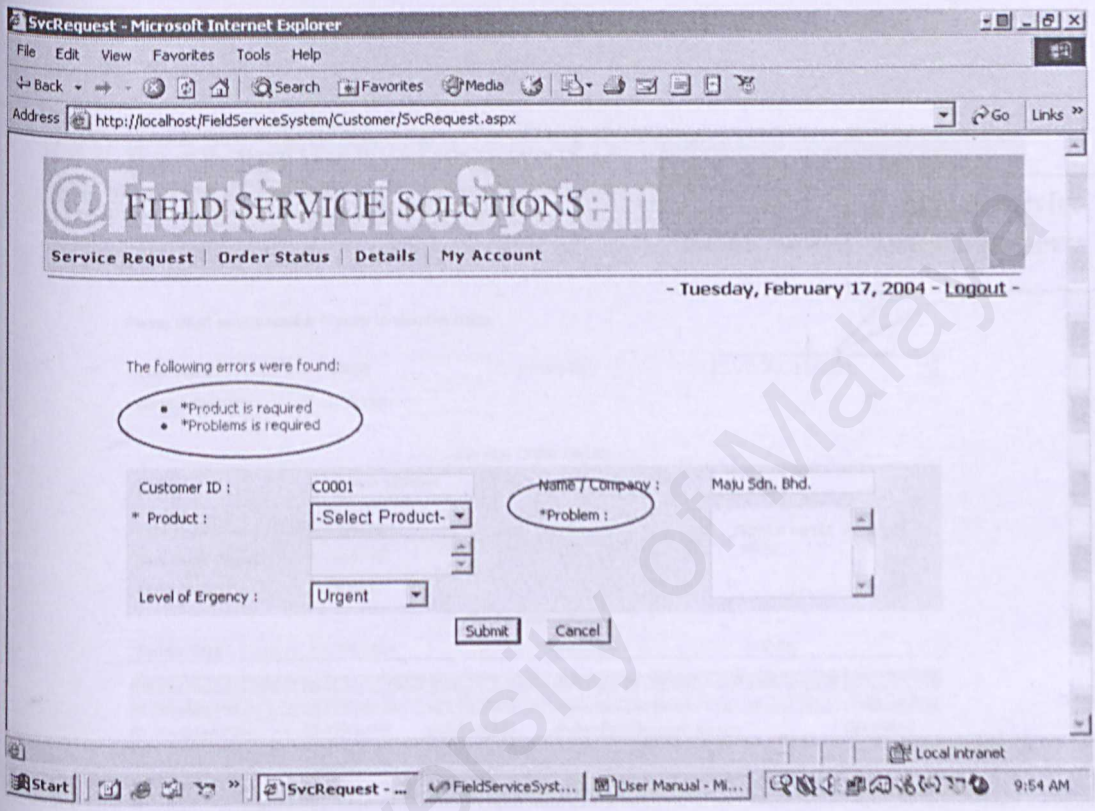


Figure 3.4.: Error Message in Service Request

3.1.2 Order Status

Customers with warranty service are able to check the order status for each service request, whether it has been assigned, completed or unassigned. They can also view details for technician(s) who provides services. For customer with maintenance contract, they can check the service date and time for preventive maintenance, as well as details for technicians.

1. To check the order status, click the 'Order Status' button from the toolbar. The

page as shown in Figure 3.5 will be displayed.

2. Select service order number from the dropdown list. Related information will be displayed based on the selected service order number.

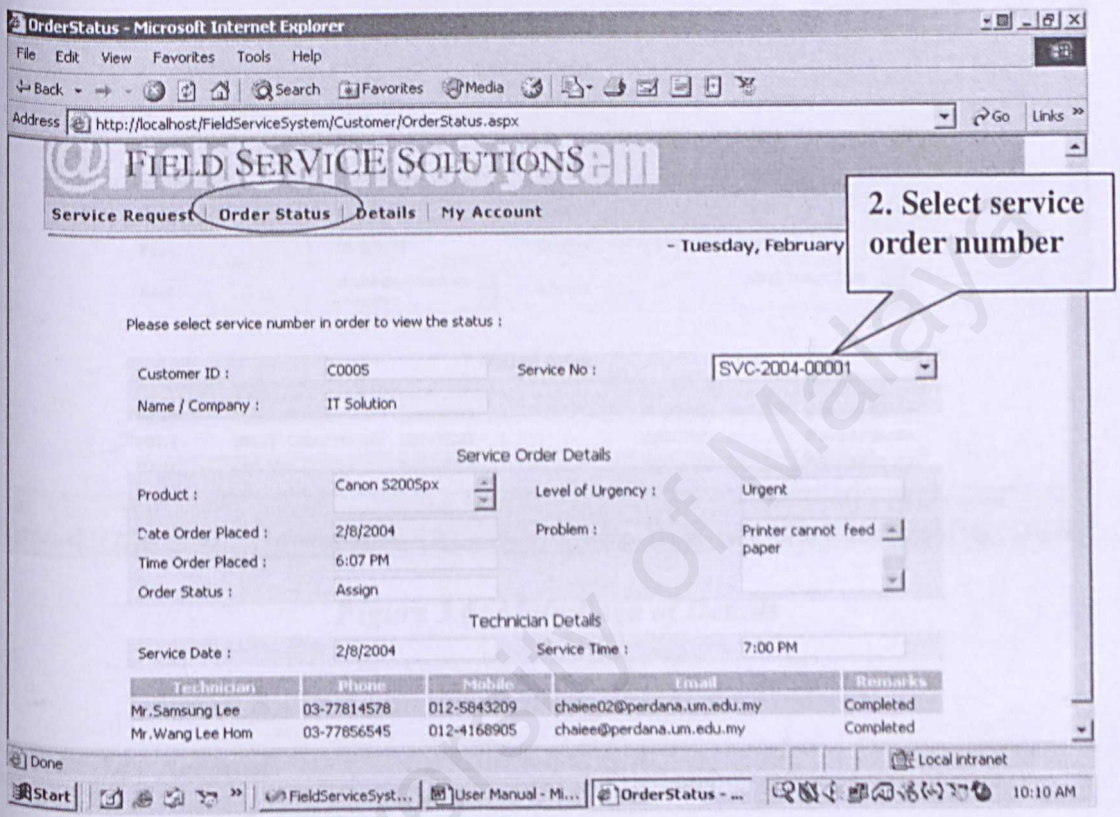


Figure 3.5.: Main Page of Order Status

3.1.3 Details

Customers with warranty service are able to view their own details and list of products brought from the company. For customers with maintenance contract, they are able to view their own details, contract details and list of products under contract.

1. To view details, click the 'Details' button from the toolbar. The page as shown in Figure 3.6 will be displayed.

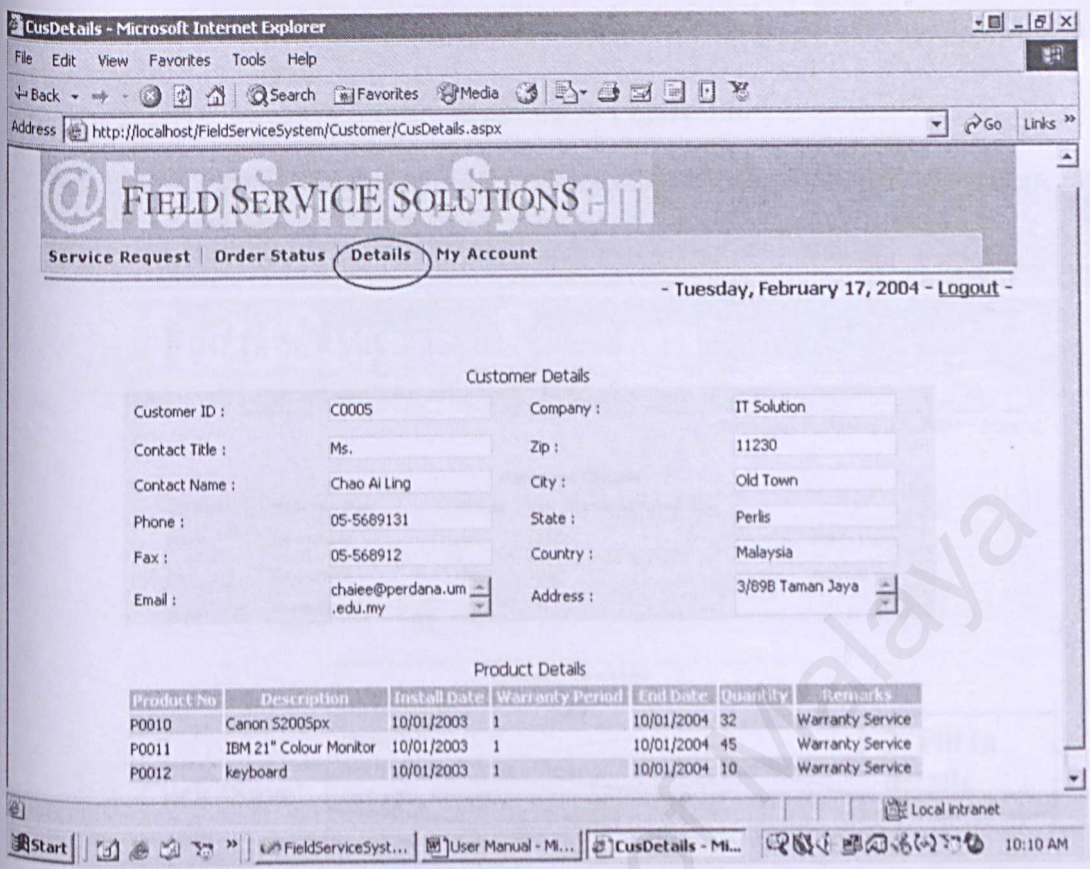


Figure 3.6: Main Page of Details

3.1.4 My Account

Customers are allowed to change their password upon their needs.

1. To change password, click the 'My Account' button from the toolbar. The page as shown in Figure 3.7 will be displayed.
2. Enter the current password into the 'Old Password' field and the new password into the 'New Password' field. Then reenter the new password in the 'Confirm password' field.
3. Click the 'Save' button. User will be directed to the Login page.
4. All the three fields required input from user. If either one field is not filled in or

the two new passwords are not matched, error message will be displayed when user click the 'Save' button as shown in Figure 3.8.

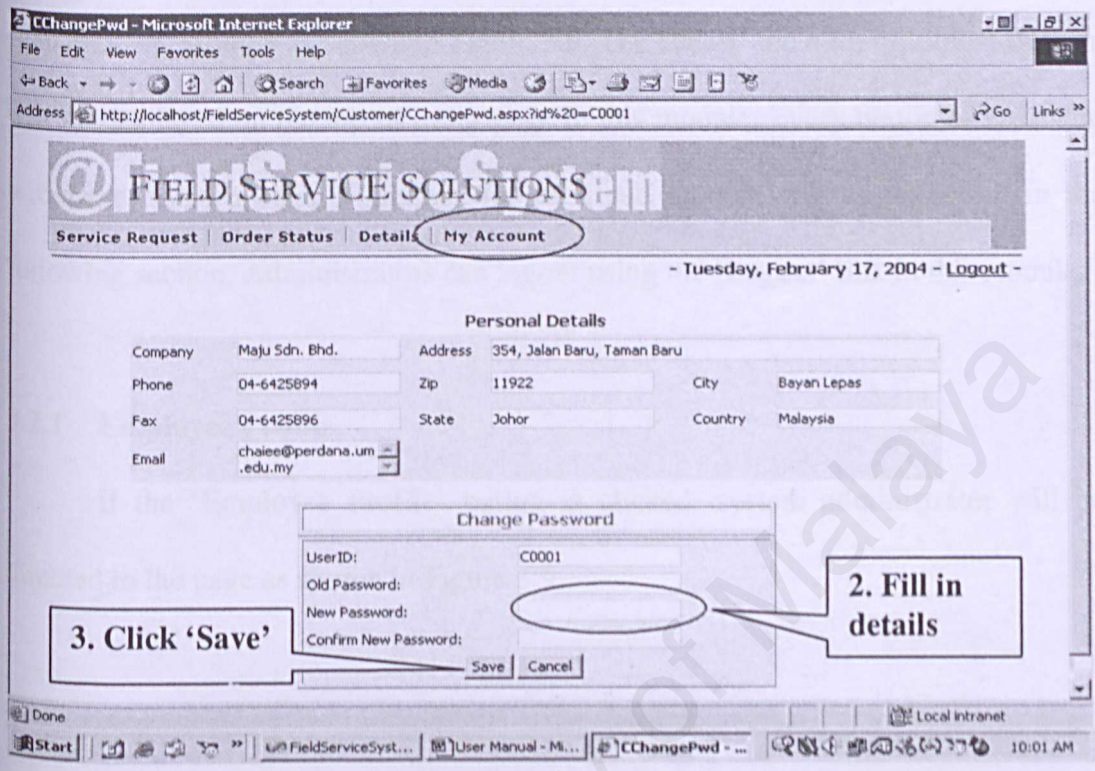


Figure 3.7: Main Page of My Account

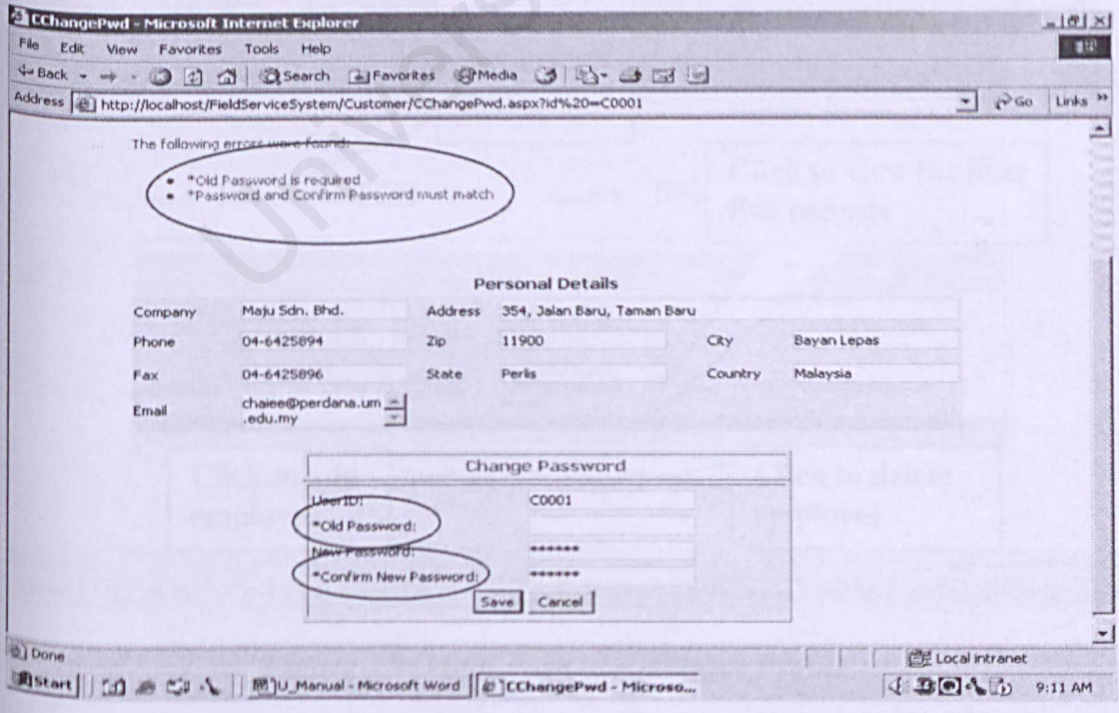


Figure 3.8: Error Message for My Account

3.2 User Management Module

If a user login as a system administrator, the user will be directed to the User Management Module as shown in Figure 3.9. The header and a set of toolbar buttons will be displayed on the top of every page in this module. Every button of the menu will have its own page. Functions for each sub module will be explained in the following section. Administrators can logout using the 'Logout' link in this module.

3.2.1 Employee Profile

If the 'Employee Profile' button is clicked, system administrator will be directed to the page as shown in Figure 3.9

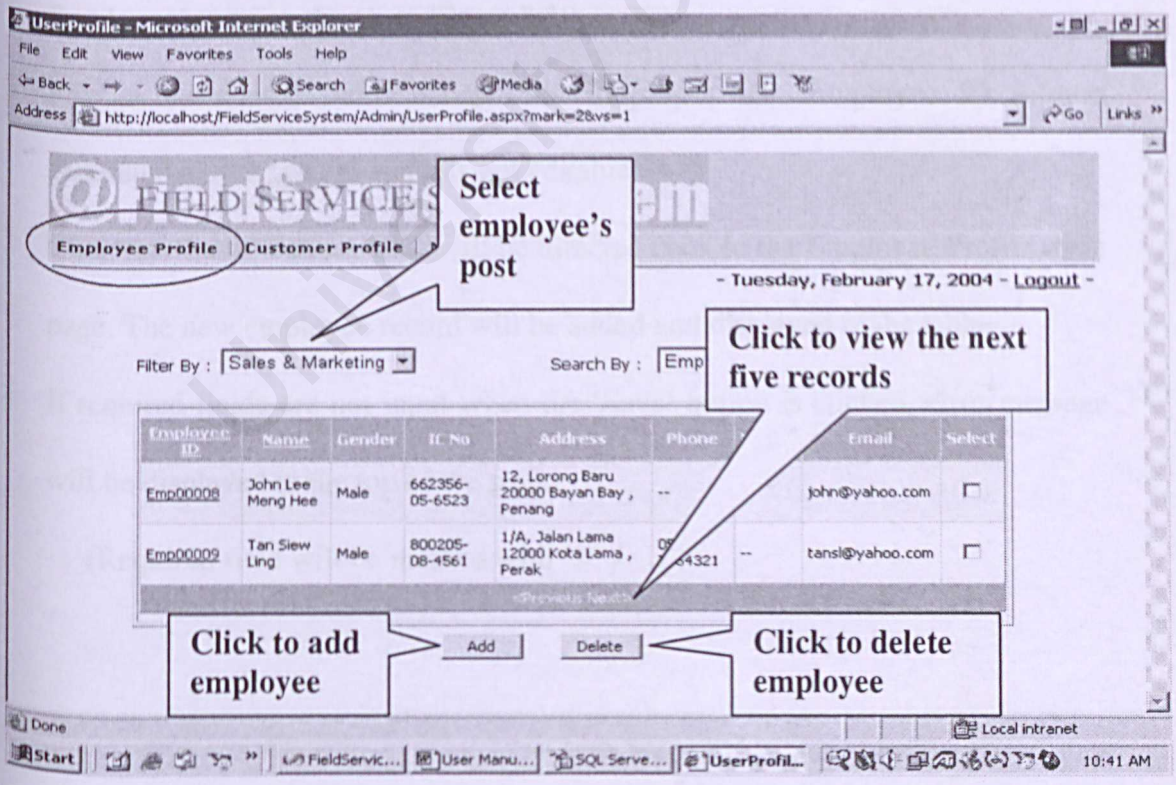


Figure 3.9: Main Page of Employee Profile

3.2.1.1 View Employee Records

1 To view employees according to their post, please select types of post from the dropdown list (Figure 3.9).

2 To view the employees' records in ascending or descending order, click on the field's name. Employees' records can be sorted by Employee ID or Name (Figure 3.9).

3 To view the remaining records, click the 'Next' link at the bottom of the table (Figure3.9).

3.2.1.2 Add New Employee

1 To add a new employee, click the 'Add' button. User will be directed to the 'Add Employee' page as shown in Figure 3.10.

2 Fill in the related fields except the 'Employee ID'. Employee ID is auto generated by the system and it is not editable.

3 Click the 'Save' button. User will be directed back to the Employee Profile main page. The new employee record will be added and displayed in the table.

4 If required fields are not input when the 'Save' button is clicked, error message will be displayed at the top of the page.

(Required field will be marked with '*')

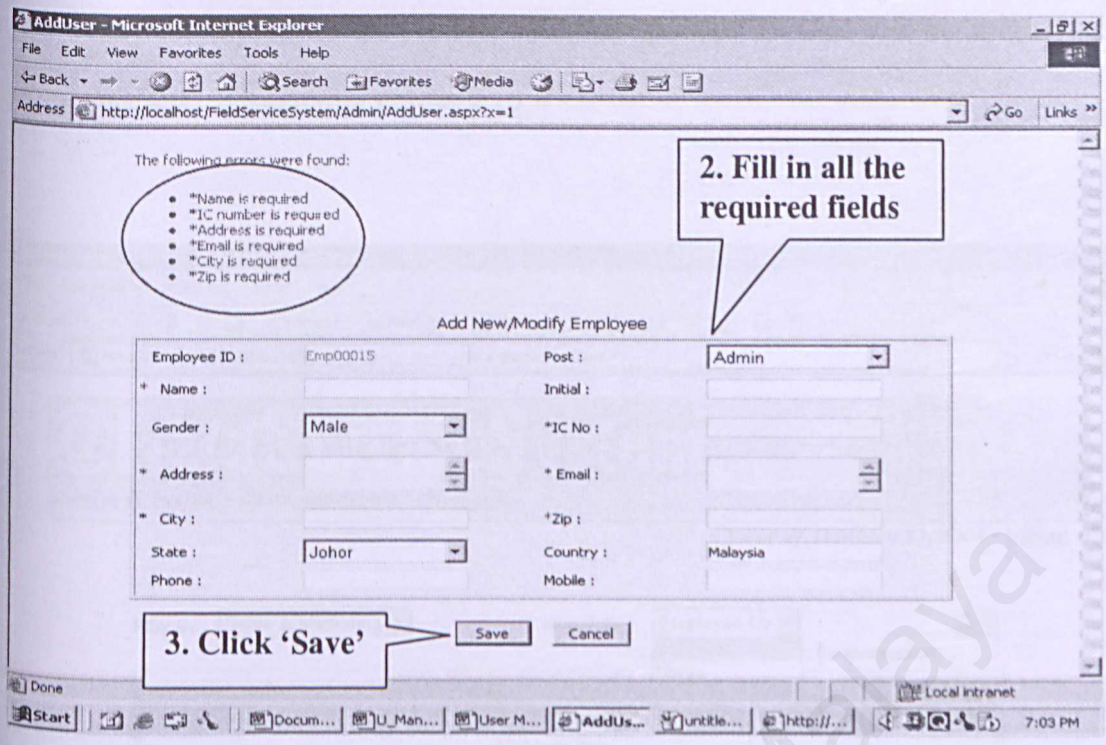


Figure 3.10: Add New Employee

3.2.1.3 Delete Employee

1 To delete employee, check the record using the checkbox. User can delete single or multiple record(s) at a time (Figure 3.9).

2 Click the 'Delete' button. A delete confirmation message will be prompted. If user clicks 'Ok', the selected record(s) will be deleted from the table.

3.2.1.4 Modify Employee Details

1 To modify employee details,

a) Click on the employee ID. User will be directed to the page as shown in Figure 3.12.

b) Use the search function as shown in Figure 3.11. If search function is used, select the field to search for, either by Employee No or Name. Then enter

keyword(s) for search. Finally, click the 'Go' button. User will be directed to the page as shown in Figure 3.12.

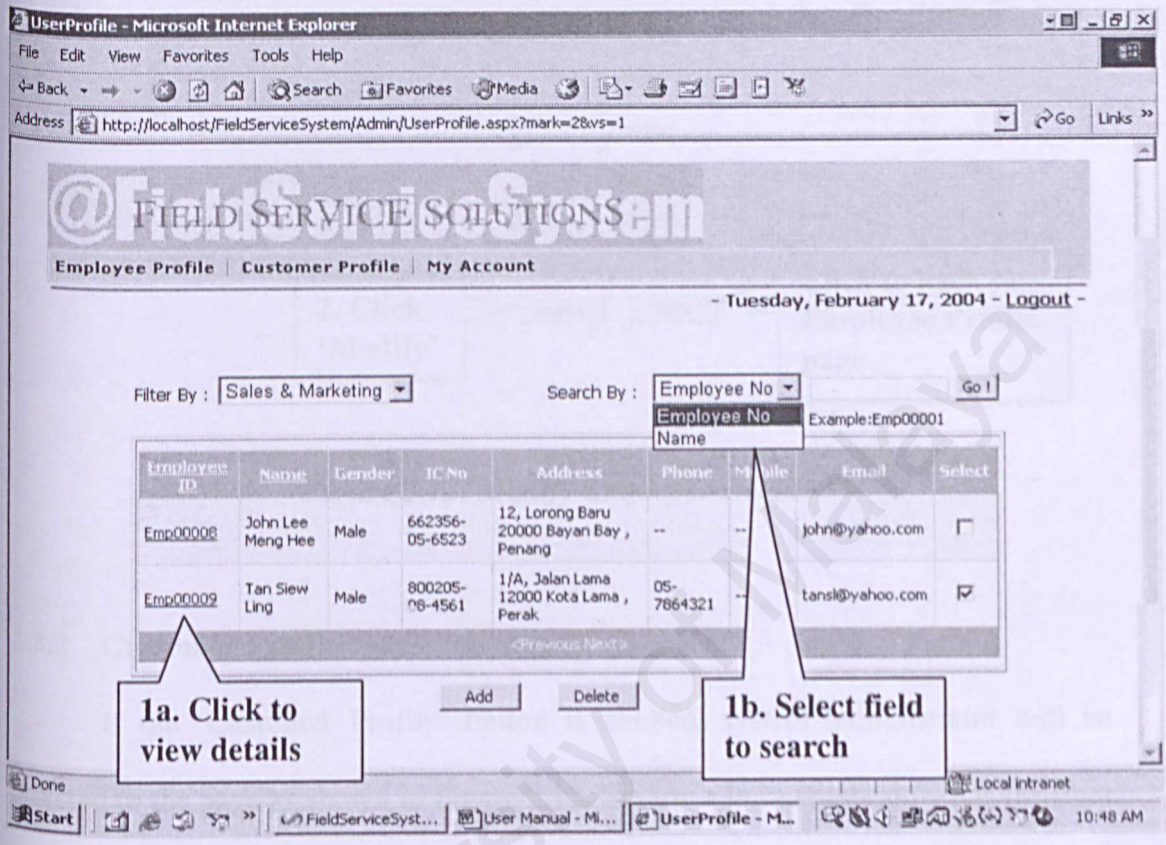


Figure 3.11: Search for Employee Details

2 To modify employee details, click the 'Modify' button (Figure 3.12).

3 Change the value for the desired field(s).

4 Click the 'Save' button. User will be directed back to the Employee Profile main page (Figure3.11).

5 If required fields are not input when the 'Save' button is clicked, error message will be displayed at the top of the page.

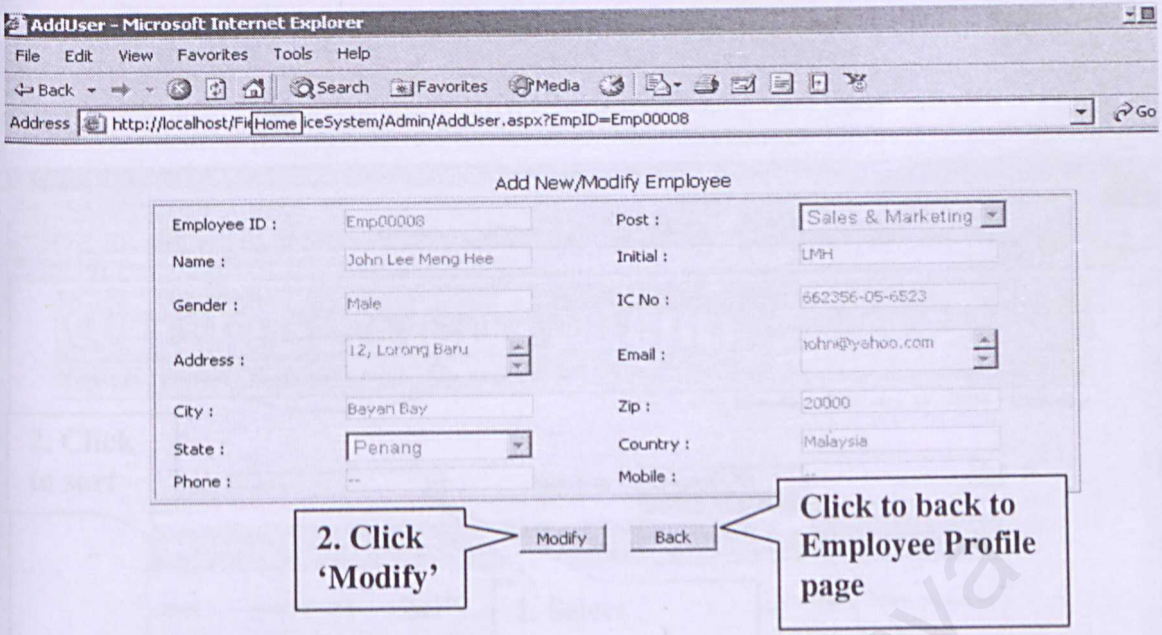


Figure 3.12: Modify Employee Details

3.2.2 Customer Profile

If the 'Customer Profile' button is clicked, system administrator will be directed to the page as shown in Figure 3.13. System administrator only has the right to view the customer details, modification is not allowed.

3.2.2.1 View Customer Records

1 By default, all the customers' records (both maintenance contract and warranty service) will be displayed when user first enter the Customer Profile main page. To view customers according to their type, please select types from the dropdown list (Figure 3.13).

2 To view the customers' records in ascending or descending order, click on the field's name. Customers' records can be sorted by Customer ID,

Name/Company and Contact Person (Figure 3.13).

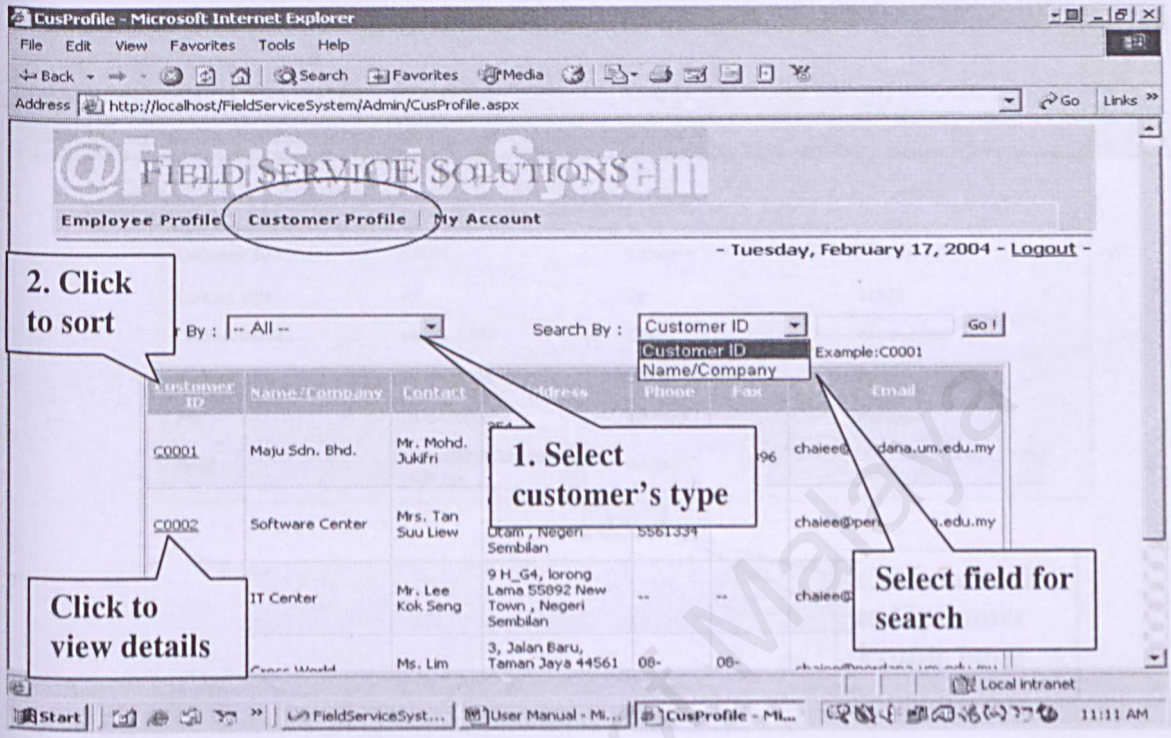


Figure 3.13: Main Page of Customer Profile

3 To view details for a particular customer,

a) Click on the customer ID. User will be directed to the page as shown in Figure3.14.

b) Use the search function as shown in Figure3.10. If search function is used, select the field to search for, either by Customer ID or Name / Company. Then enter keyword(s) for search. Finally, click the 'Go' button. User will be directed to the page as shown in Figure3.14.

If user clicks the 'Go' button without enter any keyword, a message box which asking the user to input value will be prompted (Figure 3.11).

If there is no record found, an error message "No Record is Found" will be

displayed.

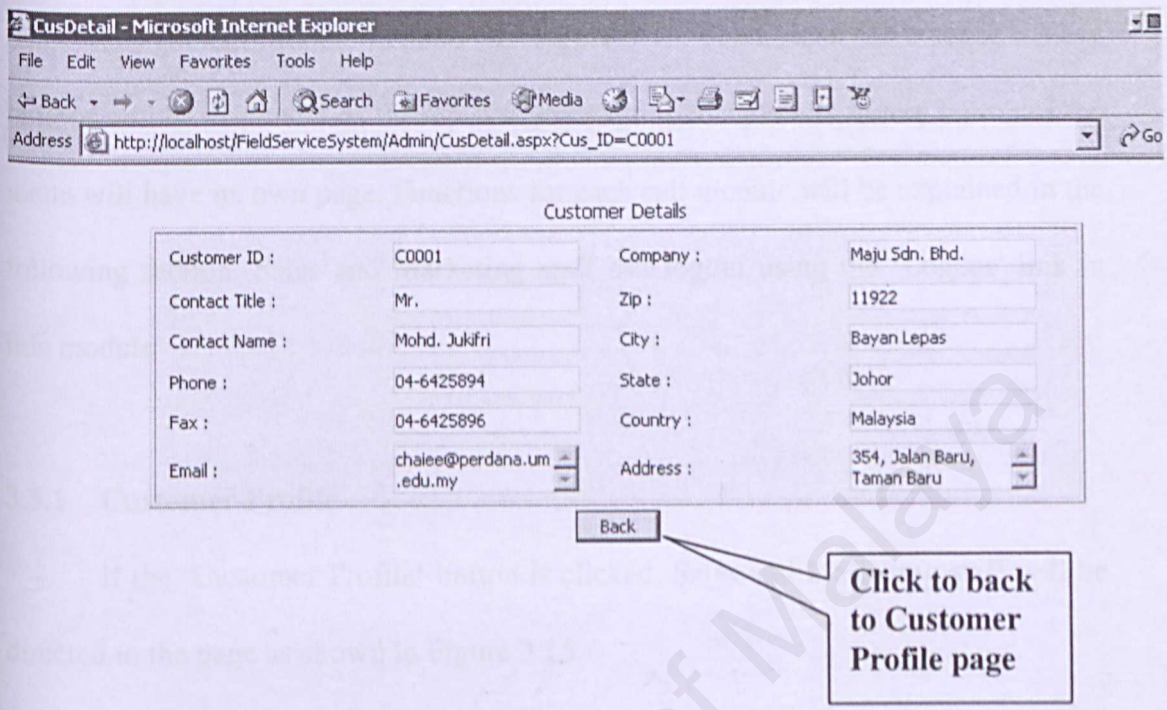


Figure 3.14: View Customer Details

3.2.3 My Account

System administrators are allowed to change their password upon their needs.

1. To change password, click the 'My Account' button from the toolbar. A page similar to Figure 3.7 will be displayed.
2. Enter the current password into the 'Old Password' field and the new password into the 'New Password' field. Then reenter the new password in the 'Confirm password' field.
3. Click the 'Save' button. User will be directed to the Login page.

3.3 Sales Management Module

If a user login as Sales and Marketing staff, the user will be directed to the Sales Management Module as shown in Figure 3.15. The header and a set of toolbar buttons will be displayed on the top of every page in this module. Every button of the menu will have its own page. Functions for each sub module will be explained in the following section. Sales and Marketing staff can logout using the 'Logout' link in this module

3.3.1 Customer Profile

If the 'Customer Profile' button is clicked, Sales and Marketing staff will be directed to the page as shown in Figure 3.15

In the Customer Profile main page, Sale and Marketing staff can view list of customer records based on their type. Various functions such as search, add and delete are provided in this page.

3.3.1.1 View Customer Records

1 By default, all the customers' records (both maintenance contract and warranty service) will be displayed when user first enter the Customer Profile main page. To view customers according to their type, please select types from the dropdown list (Figure 3.15).

2 To view the customers' records in ascending or descending order, click on the field's name. Customers' records can be sorted by Customer ID, Name/Company and Contact Person (Figure 3.15).

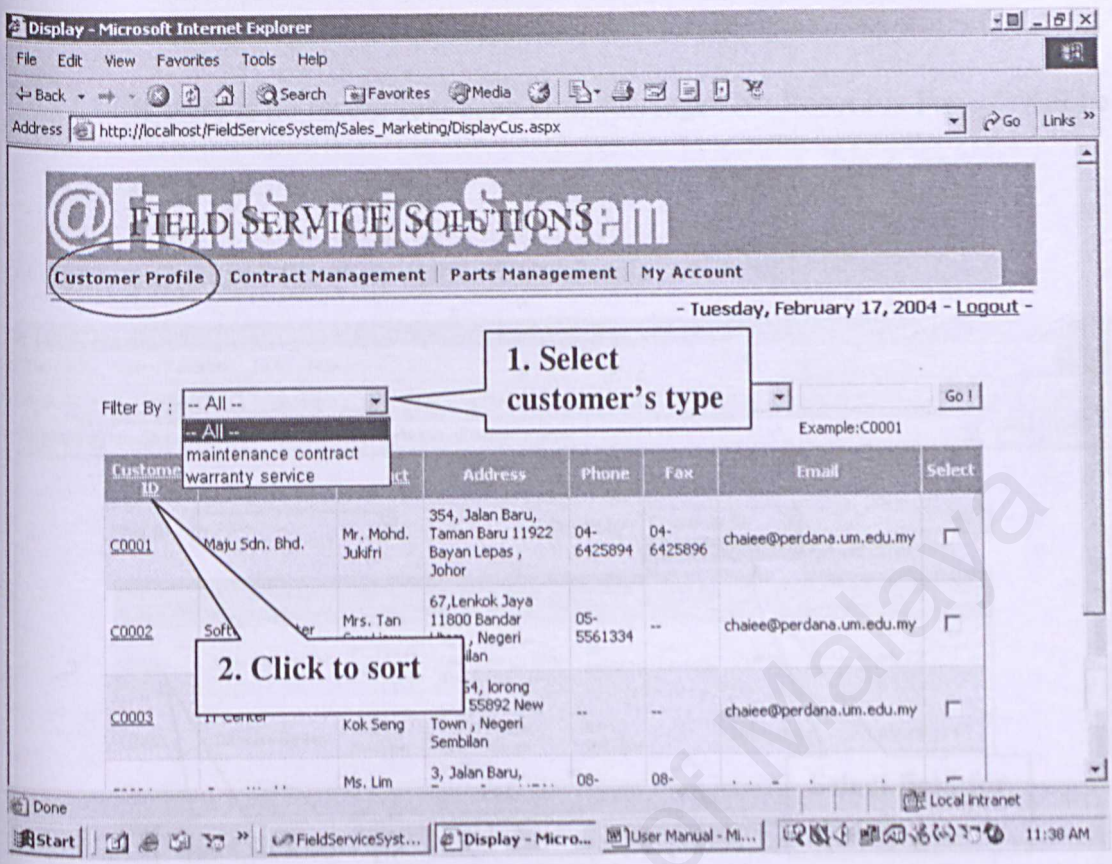


Figure 3.15: Main Page of Customer Profile

3 To view the remaining records, click the 'Next' link at the bottom of the table (Figure3.16).

4 To view details for a particular customer,

a) Click on the customer ID. User will be directed to the page as shown in Figure3.17.

b) Use the search function as shown in Figure3.16. If search function is used, select the field to search for, either by Customer ID or Name / Company. Then enter keyword(s) for search. Finally, click the 'Go' button. User will be directed to the page as shown in Figure3.17.

If user clicks the 'Go' button without enter any keyword, a message box which asking the user to input value will be prompted.

If there is no record found, an error message "No Record is Found" will be displayed.

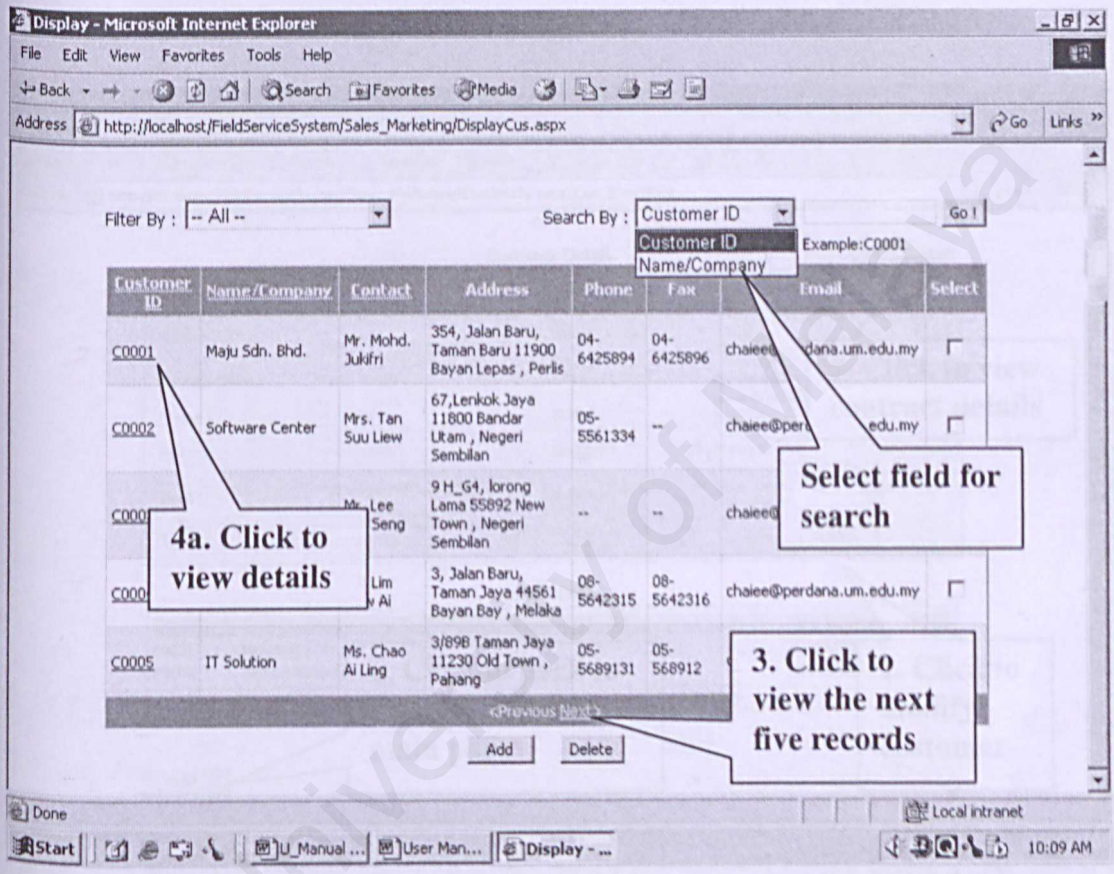


Figure 3.16: View Customer Details

3.3.1.2 Modify Customer Details

1 To modify customer details, click the 'Modify' button.

2 Change the value for the desired field(s).

3 Click the 'Save' button.

4 If required fields are not input when the 'Save' button is clicked, error message will be displayed at the top of the page.

5 To view contract details, click the 'Contract details' link. User will be directed to Contract Details page as shown in Figure 3.18.

6 Click the 'Back' button to back to the Customer Profile main page.

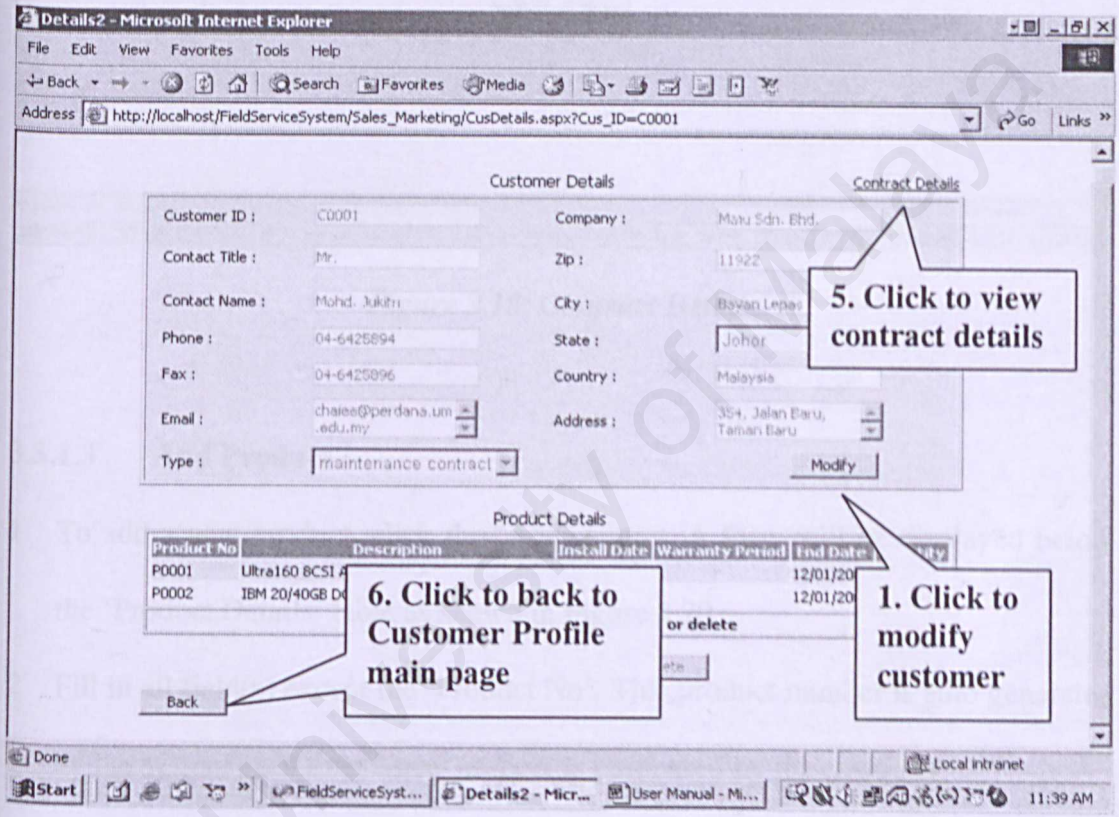


Figure 3.17: Customer Details

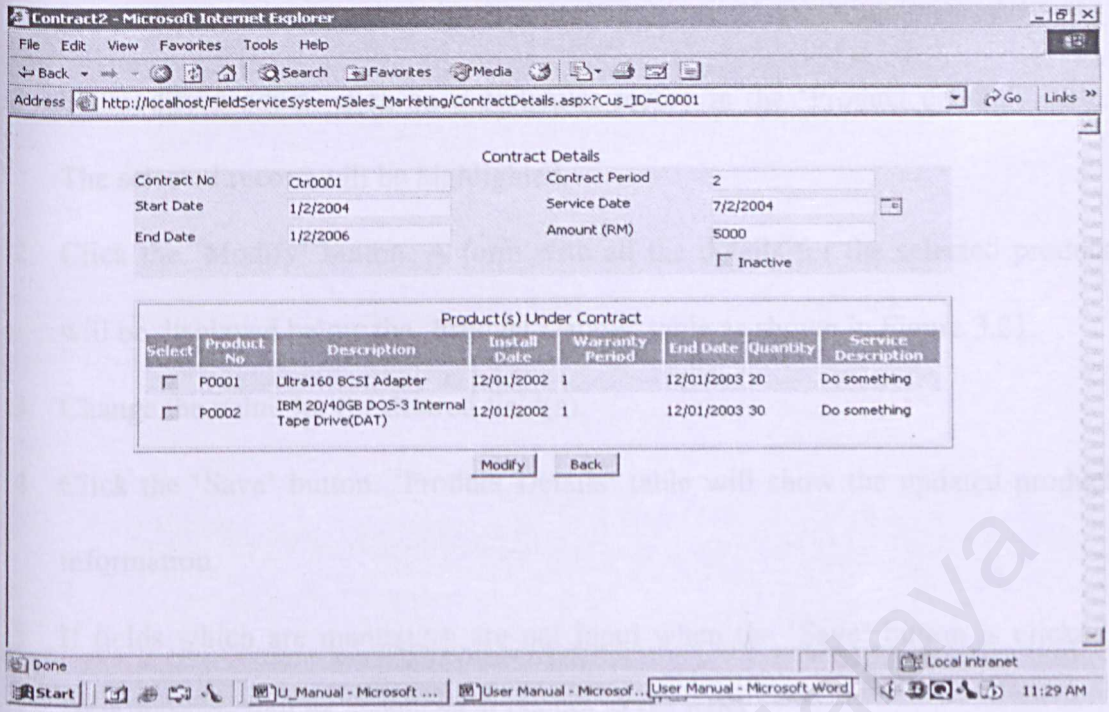


Figure 3.18: Contract Details

3.3.1.3 Add Product

1 To add a new product, click the 'Add' button. A form will be displayed below the 'Product Details' table as shown in Figure 3.20.

2 Fill in all field(s) except the 'Product No'. This product number is auto generated by the system each time a new product is purchased by the customer.

3 Click the 'Save' button. The new product will be added and it will appear in the 'Product Details' table.

4 If fields which are mandatory are not input when the 'Save' button is clicked, error message will be displayed at the top of the page.

5 Click the 'Back' button to back to the Customer Profile main page.

3.3.1.4 Modify Product

1 To modify product, click on a particular record in the 'Product details' Table. The selected record will be highlighted.

2 Click the 'Modify' button. A form with all the details for the selected product will be displayed below the 'Product Details' table as shown in Figure 3.21.

3 Change the value for the desired field(s).

4 Click the 'Save' button. 'Product Details' table will show the updated product information.

5 If fields which are mandatory are not input when the 'Save' button is clicked, error message will be displayed at the top of the page.

6 Click the 'Back' button to back to the Customer Profile main page.

3.3.1.5 Delete Product

1 To delete product, click on a particular record in the 'Product Details' Table. The selected record will be highlighted.

2 Click the 'Delete' button. The selected product will be deleted from the 'Product Details' table.

3 Click the 'Back' button to back to the Customer Profile main page.

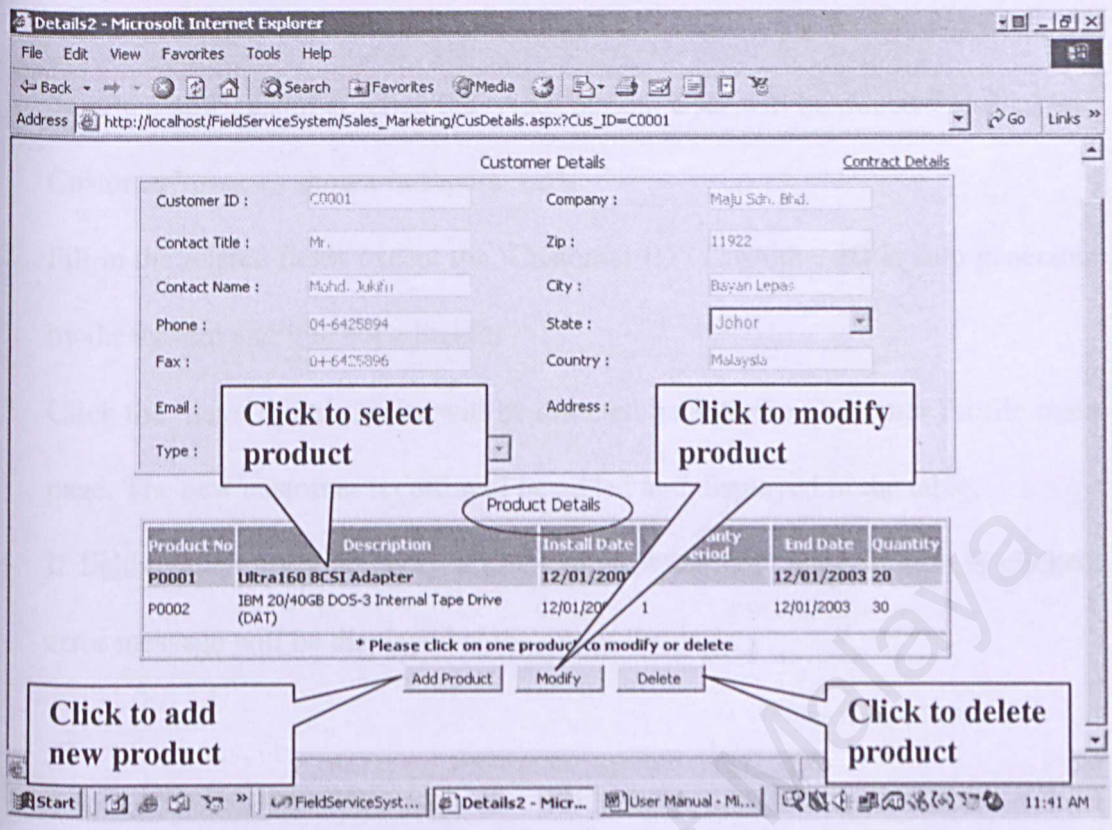


Figure 3.19: Product Details

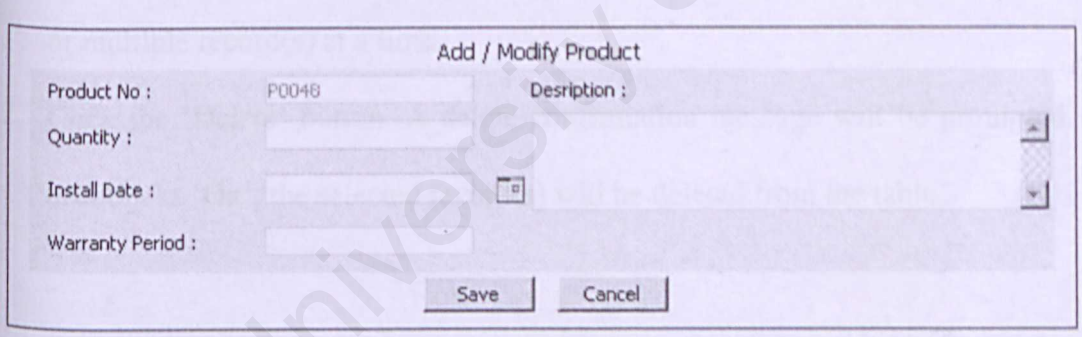


Figure 3.20: Add New Product

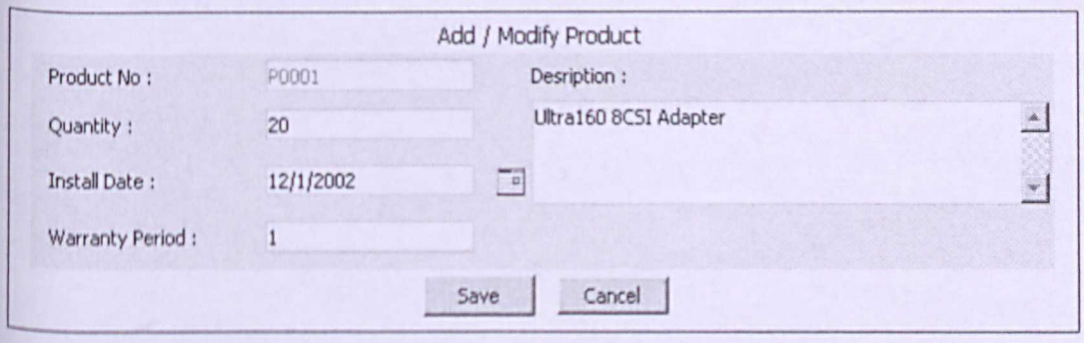


Figure 3.21: Modify Product

3.3.1.6 Add New Customer

1 To add a new customer, click the 'Add' button. User will be directed to the 'Add Customer' page as shown in Figure 3.23.

2 Fill in the related fields except the 'Customer ID'. Customer ID is auto generated by the system and it is not editable.

3 Click the 'Save' button. User will be directed back to the Customer Profile main page. The new customer record will be added and displayed in the table.

4 If fields which are mandatory are not input when the 'Save' button is clicked, error message will be displayed at the top of the page.

3.3.1.7 Delete Customer

1 To delete customer, check the record using the checkbox. User can delete single or multiple record(s) at a time.

2 Click the 'Delete' button. A delete confirmation message will be prompted. If user clicks 'Ok', the selected record(s) will be deleted from the table.

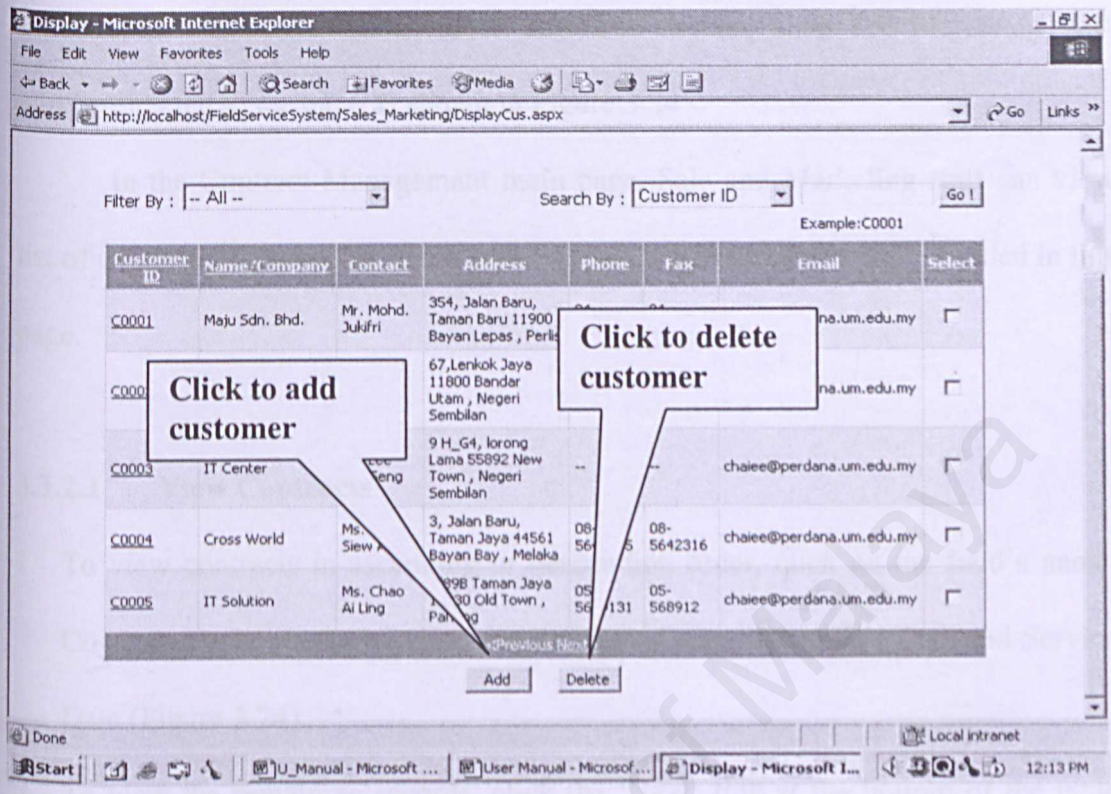


Figure 3.22: Add / Delete Customer

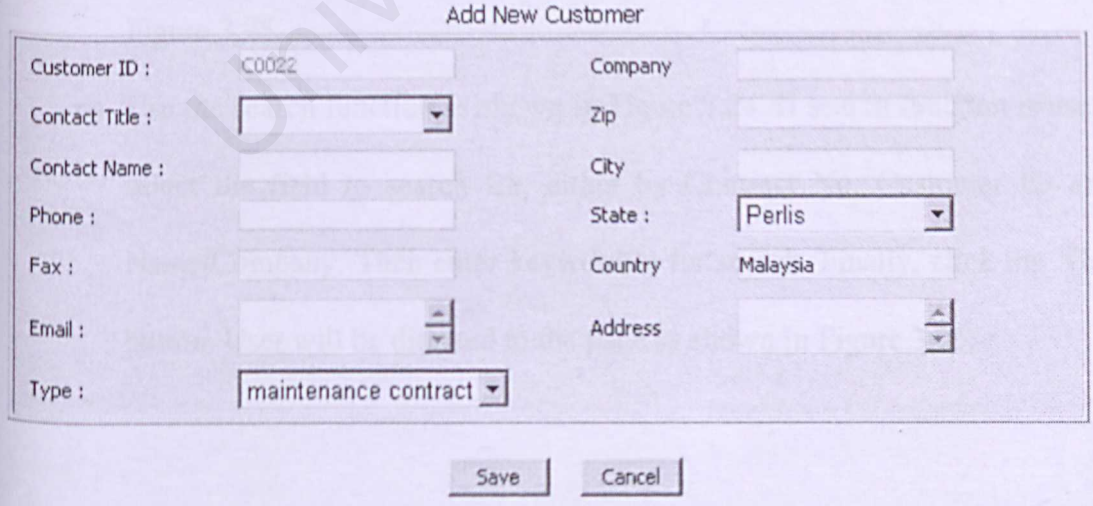


Figure 3.23: Add New Customer

3.3.2 Contract Management

If the 'Contract Management' button is clicked, Sales and Marketing staff will be directed to the page as shown in Figure 3.24

In the Contract Management main page, Sale and Marketing staff can view list of contracts. Various functions such as search, add and delete are provided in this page.

3.3.2.1 View Contracts

1 To view contracts in ascending or descending order, click on the field's name. Contract can be sorted by Contract No, Period, Start Date, End Date and Service Date (Figure 3.24).

2 To view the remaining records, click the 'Next' link at the bottom of the table (Figure 3.24).

3 To view details for a particular contract,

c) Click on the Contract No. User will be directed to the page as shown in Figure 3.25.

d) Use the search function as shown in Figure 3.24. If search function is used, select the field to search for, either by Contract No, Customer ID and Name/Company. Then enter keyword(s) for search. Finally, click the 'Go' button. User will be directed to the page as shown in Figure 3.25.

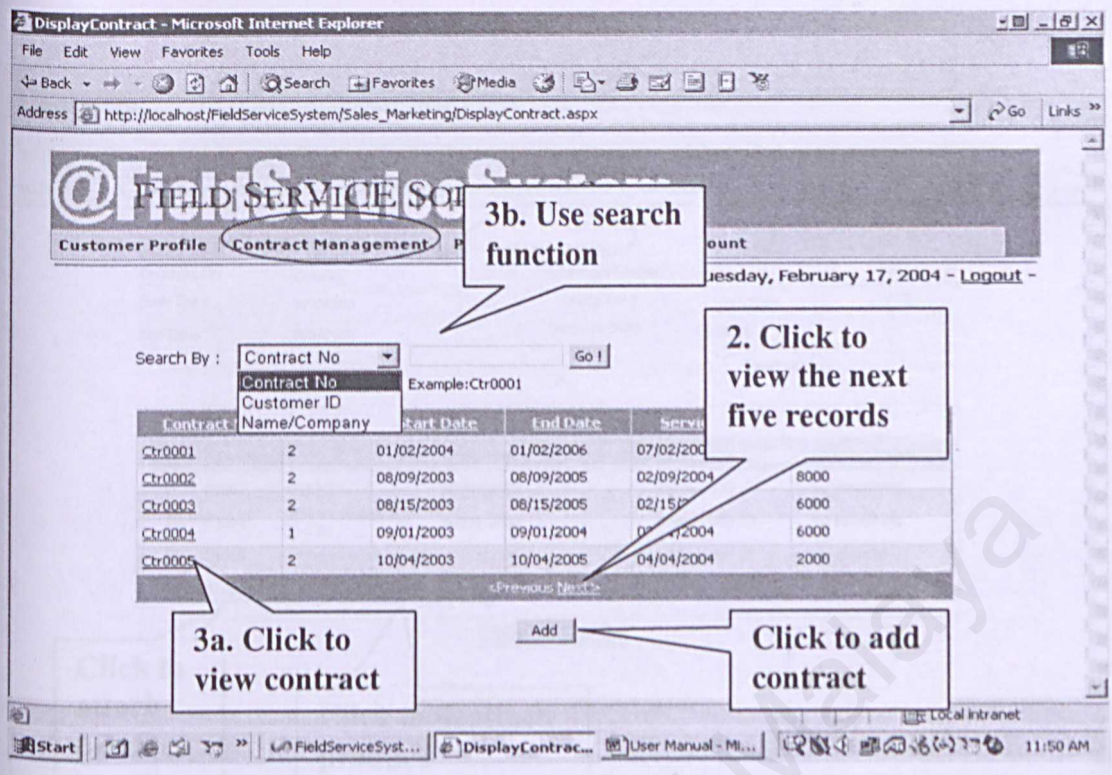


Figure 3.24: Main Page of Contract Management

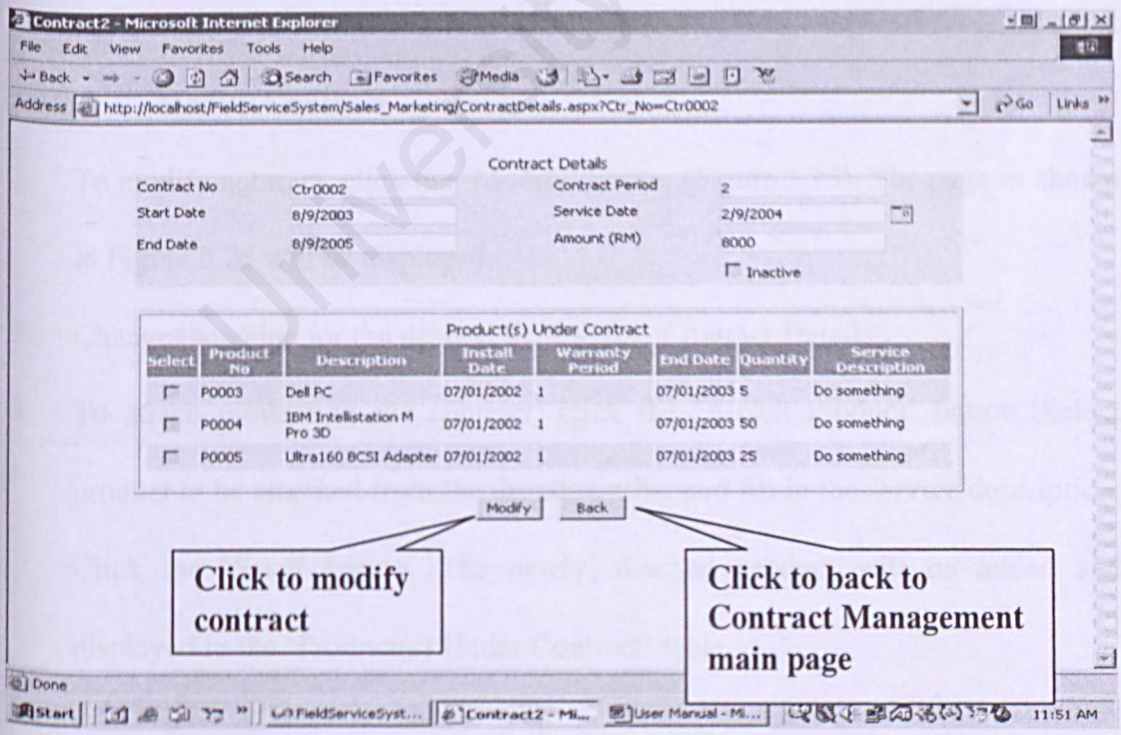


Figure 3.25: Contract Details

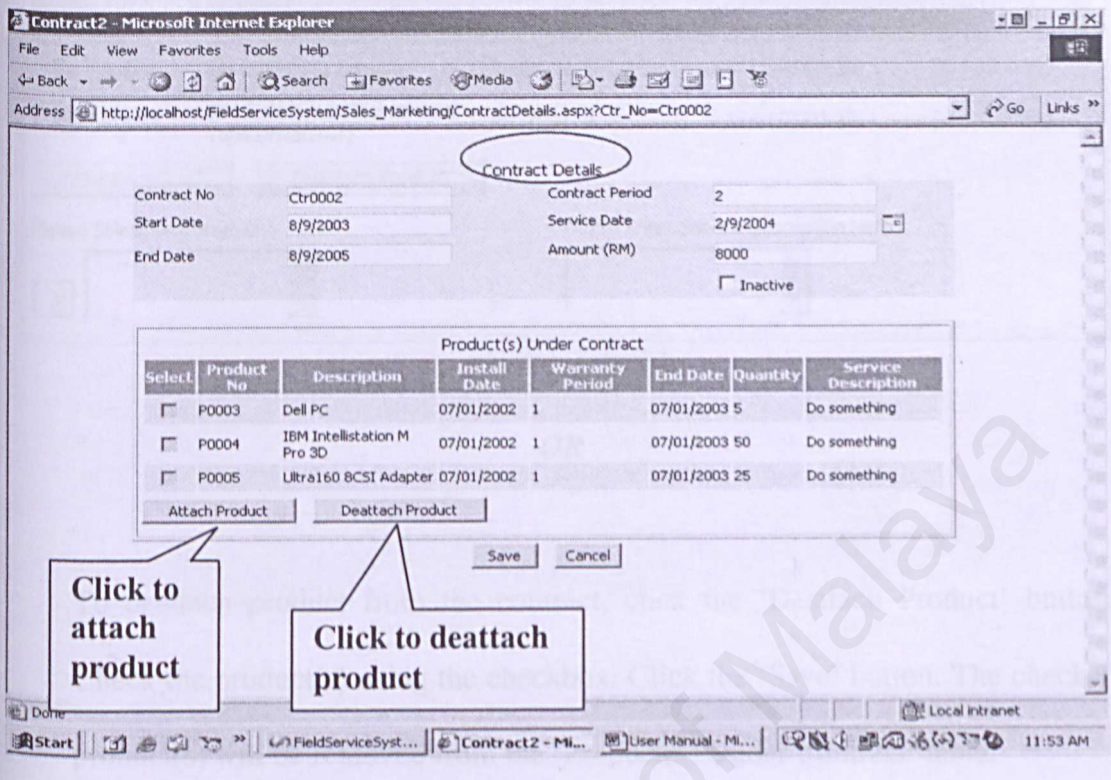


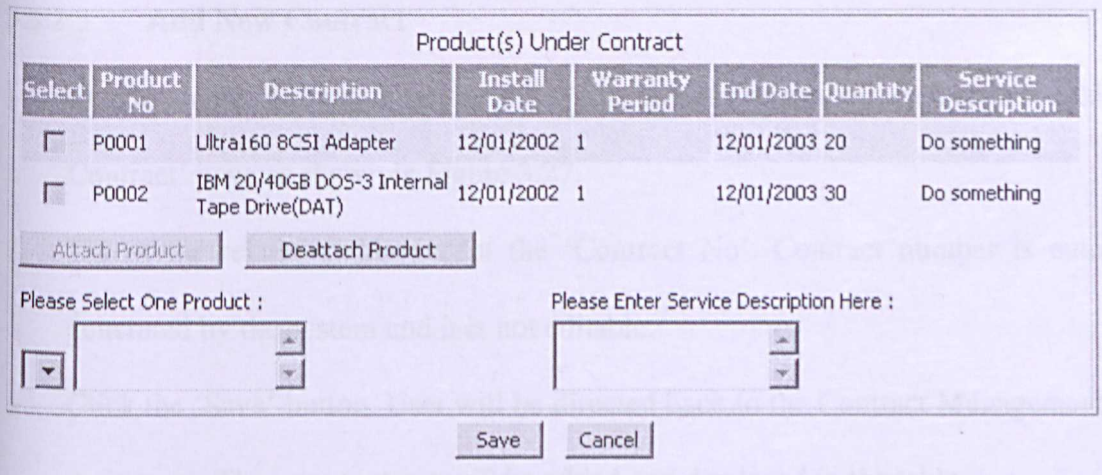
Figure 3.26: Modify Contract

3.3.2.2 Modify Contract

1 To modify contract, click the 'Modify' button (Figure 3.25). The page as shown in Figure 3.26 will be displayed.

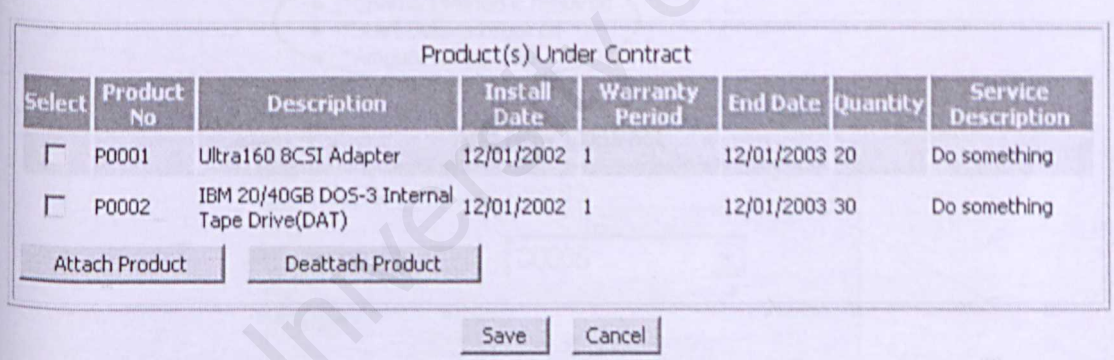
2 Change the value for the desired field(s) for 'Contract Details'.

3 To attach product to the contract, click the 'Attach Product' button. Select product to be attached from the dropdown list and fill in the service description. Click the 'Save' button. The newly attached product will be added and displayed in the 'Product(s) Under Contract' table.



OR

To deattach product from the contract, click the 'Deattach Product' button. Check the product(s) using the checkbox. Click the 'Save' button. The checked product(s) will be removed from the 'Product(s) Under Contract' table.



4 If required fields are not input when the 'Save' button is clicked, error message will be displayed at the top of the page.

5 Click the 'Back' button to back to the Contract Management main page.

3.3.2.3 Add New Contract

1 To add a new contract, click the 'Add' button. User will be directed to the 'Add Contract' page as shown in Figure 3.27.

2 Fill in the related fields except the 'Contract No'. Contract number is auto generated by the system and it is not editable.

3 Click the 'Save' button. User will be directed back to the Contract Management main page. The new contract will be added and displayed in the table.

4 If required fields are not input when the 'Save' button is clicked, error message will be displayed at the top of the page.

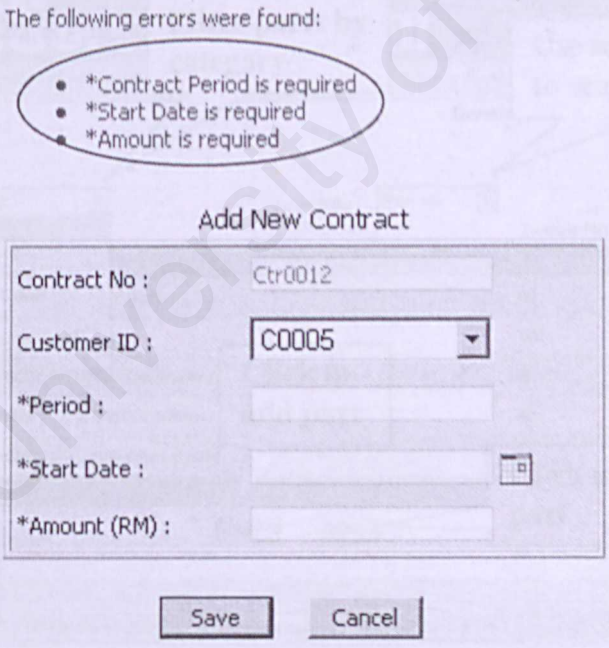


Figure 3.27: Add New Contract

3.3.3 Parts Management

If the 'Parts Management' button is clicked, Sales and Marketing staff will be directed to the page as shown in Figure 3.28

In the Parts Management main page, Sale and Marketing staff can view list of parts. Various functions such as search, add and delete are provided in this page. Generally, the procedures involved in performing those functions are the same as in the Customer Profile and Contract Management module.

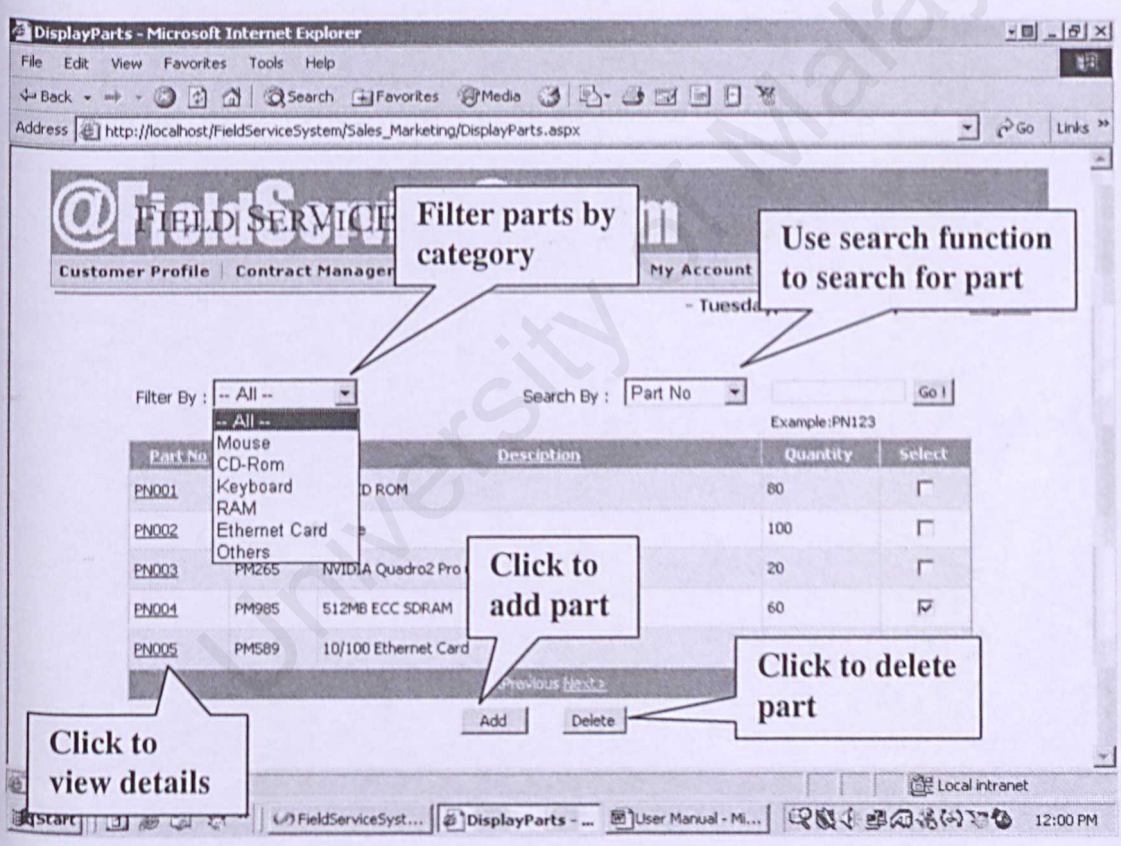


Figure 3.28: Main Page of Parts Management

3.3.4 My Account

Sales and Marketing staff are allowed to change the password upon their needs.

1. To change password, click the 'My Account' button from the toolbar. A page similar to Figure 3.7 will be displayed.
2. Enter the current password into the 'Old Password' field and the new password into the 'New Password' field. Then reenter the new password in the 'Confirm password' field.
3. Click the 'Save' button. User will be directed to the Login page.